

**5.1 INTRODUCTION.**

5.2 This section contains maintenance information for the counter. Included are TTL theory, ECL theory, diode gate theory, signal flow in all modes of operation, troubleshooting, and diagrams to localize, isolate and locate defective components. Performance check procedures are not included in this section, but can be found in Section 3.

**5.3 RECOMMENDED TEST EQUIPMENT.**

5.4 Test equipment recommended for maintaining, troubleshooting, and servicing the counter is listed in table 5.1. Test equipment with equivalent characteristics may be substituted for equipment listed.

**5.5 CALIBRATION.****5.6 Internal Reference Oscillator Adjustment.**

5.7 The following procedures are given for adjustment of the counter's internal reference oscillator. One of three different reference oscillators may be used in the counter. The reference oscillators are as follows:

- a. Standard Temperature-Compensated Crystal Oscillator (TCXO); Dana part number 730551

- b. Option 050 Temperature-Compensated Crystal Oscillator (TCXO); Dana part number 730578

- c. Option 200 Temperature-Compensated Reference Oscillator (TCRO); Dana part number 730228

5.8 For standard and option 050 reference oscillators, perform the following set-up procedures.

- a. Set the counter controls as follows:

Control	Setting
DISPLAY TIME	about 9 o'clock
FUNCTION	FREQ A
TIMEBASE	10 second
A Slope	Plus (+)
A Coupling	DC
A Trigger Level	PRESET
SEP/COM	SEP
STORAGE	ON
REF	INT OUT
A Input Voltage Range	10

**Table 5.1 - Required Equipment**

Instrument Type	Required Specification	Recommended Instruments
Frequency Standard	1 MHz, 5 MHz, or 10 MHz	
Oscilloscope	150 MHz Bandwidth 500 MHz Bandwidth	TEK 454 TEK 7900
Voltmeter	10 mVDC to 200 VDC	Dana 4300
Sine Wave Generator	2 Hz – 10 MHz	Dana 7010
VHF Signal Generator	10 – 150 MHz	HP8654A
VHF Signal Generator	1 – 550 MHz (Not required for 8010B)	HP8654A
Pulse Generator	4 ns pulselength	Datapulse 112
Alignment Tool	.075" Hex (nonmetallic)	General Cement 9300
Alignment Tool	Blade (nonmetallic)	
Sampling Voltmeter	0 – 600 MHz	HP3406
BNC "T" connector		
50Ω Tee connector		HP 10221A
2 – BNC to GR Adaptors		

- b. Connect a 1 MHz frequency standard to A input.
- c. Allow 1 hour time for the counter temperature to stabilize.
- d. The difference between the internal reference oscillator and the 1 MHz frequency standard can be determined by the following formula:  

$$\text{Internal Oscillator Frequency} = (20,000,000 - \text{Counter Reading})$$
. See table 5.2.

**Table 5.2 - Reference Oscillator Error**

Counter Display	Internal Reference Osc.
999.9950 kHz	10000.050 kHz
999.9975 kHz	10000.025 kHz
1000.0000 kHz	10000.000 kHz
1000.0025 kHz	9999.975 kHz
1000.0050 kHz	9999.950 kHz

### 5.9 ADJUSTMENT PROCEDURE – STANDARD TCXO.

#### **WARNING**

Removal of covers exposes potentially lethal voltages. Avoid contact with internal electrical connections while unit is connected to AC power source.

- a. Apply power to the counter for one hour before attempting TCXO adjustment (see paragraph 5.8). Remove the top cover (see paragraph 5.18, "Access to P.C. Boards"). Locate the TCXO located on the Readout assembly near the rear of the counter (see figure 6.5, Readout Layout). Remove the #6 metal or nylon cap screw on the top of the reference oscillator. Use a nonmetallic alignment tool for adjustment. Some oscillators require a hexagon .075 dia. alignment tool, and others require a blade type.
- b. Insert the proper adjustment tool into the #6 screw hole on the top of the reference oscillator. Adjust the TCXO until the display reads 1000.0000 kHz. Wait ten seconds and readjust the TCXO if the first adjustment was not correct. Remove the adjustment tool.
- c. After the initial adjustment, replace the cap screw and the top cover. Allow 30 minutes for temperature stabilization and recheck the reading.

### 5.10 ADJUSTMENT PROCEDURE – OPTION 051 TCXO.

5.11 Allow the counter to temperature stabilize for one hour before adjustment and verify one hour after adjustment. Follow the procedures outlined in paragraph 5.9.

### 5.12 ADJUSTMENT PROCEDURE – OPTION 206 TCRO.

5.13 The object of the following procedures is to determine short term drift of the TCRO as well as to adjust the frequency. The adjustments are the COARSE and FINE controls on the rear panel. *Use only a non-metallic blade type adjustment tool for these adjustments.*

- a. Set the counter controls as described in paragraph 5.8a.
- b. Allow the counter to temperature stabilize for 72 hours before calibration. (It is not necessary to turn the power on during the warmup and stabilization period. The TCRO is an oven oscillator which operates from a separate +28 volt supply.) Set DISPLAY TIME to about 9 o'clock one hour before adjustment.
- c. Connect a 1 or 5 MHz Frequency Standard to channel 1 of a dual channel oscilloscope. Trigger the oscilloscope on channel 1 only. Set the oscilloscope sweep rate to .02  $\mu$ s per cm.
- d. Connect a BNC cable to the counter INT OUT connector J106 on the rear panel. Set the REF switch S102 to the INT OUT position. Connect the other end of the BNC cable to the second channel of the oscilloscope. The oscilloscope display should indicate a stationary and a moving waveform. The moving waveform is the counter reference oscillator.
- e. Remove the nylon cap screws. Adjust the COARSE adjustment (rear panel, see figure 6.8) and then the FINE adjustment until as near a completely stable waveform as possible is obtained. The channel 2 waveform will be drifting to the left or right. If the channel 2 waveform is moving to the left, the internal reference oscillator is higher in frequency than the frequency standard. If the channel 2 waveform moves to the right, the internal reference oscillator is lower in frequency than the frequency standard.
- f. To determine the drift rate, measure the time it takes the oscilloscope pattern to drift the width of one cycle on channel 2. Note: 1 cycle equals 5 divisions on the oscilloscope. The oscillator drift can be determined from figure 5.1.

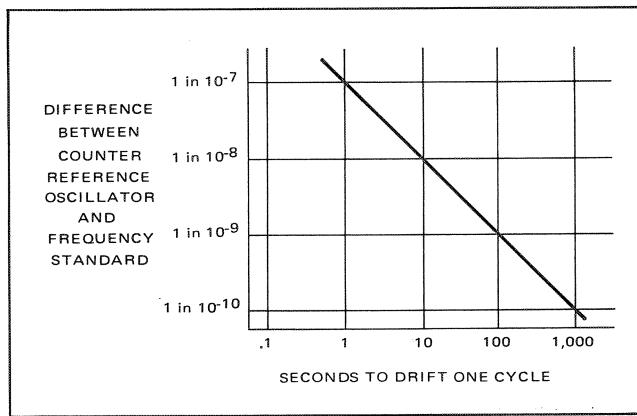


Figure 5.1 - Oscillator Drift

#### 5.14 SIGNAL CONDITIONING CALIBRATION – CHANNEL A.

- Set the controls as follows:

Control	Setting
A Slope	(+) Plus
A Coupling	AC
MULTIPLIER/TIMEBASE	1 second
A Trigger Level	PRESET
A Voltage Input Range	1
SEP/COM	SEP
FUNCTION	FREQ A
DISPLAY TIME	about 9 o'clock

- Apply power to the counter 1 hour before adjustment. Do not remove the top or bottom covers during warmup.
- Apply a 10 MHz 100 mV rms signal to channel A input. Use a DC coupled oscilloscope with .5V/cm sensitivity to compare logic levels at MD1-12 and MD2-8 on the switch board assembly. Refer to figure 6.3, Switch Board Layout, for locations.
- Adjust the ECL level pot R17A (figures 5.3 and 6.1) so the logic levels at MD1-12 are the same as the logic levels at MD2-8.
- Connect a 150 MHz, 40 mV RMS signal to channel A input.
- While observing the signal at MD1-12, switch the channel A slope between (+) plus and minus (-).

Note the DC voltage shift between + and - slopes. Adjust the offset pot R20A for a minimum DC shift. Notice that with no DC shift, a permissible change in peak-to-peak amplitude may occur. The signal at MD1-12 is shown in figure 5.2. The signal output in either slope must be a minimum of .4 volts peak-to-peak.

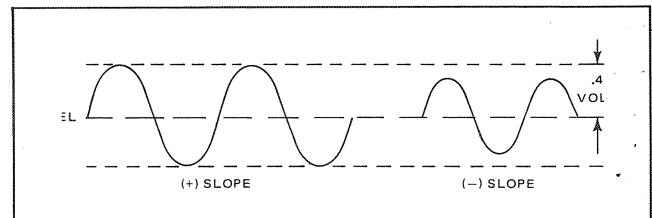


Figure 5.2 - Signal Conditioner Output

- Check the sensitivity over the band in both + and - slopes. Nominal sensitivities are as follows:  
50 mV RMS to 100 MHz, 100 mV RMS to 150 MHz.
- Place channel A in - slope. Increase signal level to insure that the proper reading is displayed by counter. Incrementally decrease input signal level until an improper reading is observed. Then adjust R17A for the correct reading. Continue this process until maximum sensitivity is obtained.
- Final check and adjustment should be completed after the unit is at ambient temperature with the top and bottom covers on.

#### 5.15 SIGNAL CONDITIONING CALIBRATION – CHANNEL B

- Set the Controls as follows:

Control	Setting
Slope A	+
Slope B	-
Coupling A	AC
Coupling B	AC
Trigger Level A	PRESET
Trigger Level B	PRESET
Input Range A	1
Input Range B	1
SEP/COM	SEP
FUNCTION	TIA
DISPLAY TIME	about 9 o'clock
MULTIPLIER/TIMEBASE	1 second

- b. Apply power to the counter 1 hour before adjustment. Do not remove top and bottom covers during warmup period.
- c. Apply a 10 MHz 100 mV rms signal to channel A input. Apply the same signal to a 10 dB Attenuator. Connect the output of the attenuator to channel B input.
- d. Monitor the signal output of signal conditioner at ME0-6 on the Switch Board assembly. (figure 6.3)
- e. Use a DC coupled oscilloscope with .5V/cm sensitivity and compare logic levels at ME0-6 and MC1-8 on the Switch board.
- f. Adjust the ECL level control R17 (figures 5.3 and 6.1) such that the logic levels at ME0-6 are the same as the logic levels at MC1-8.
- g. Incrementally decrease input signal level until an improper reading is observed. Then adjust R20 for the correct reading. Continue this process until maximum sensitivity is obtained.
- h. Check the sensitivity over the band in both + and - slopes. Nominal sensitivities are: 0 – 10 MHz, 50 mV RMS.
- i. Final check and adjustments should be completed after the counter is at ambient temperature with both top and bottom covers on.

## 5.16 PERIODIC MAINTENANCE.

5.17 To determine if the counter is operating properly within specifications, perform the performance check (Section 3).

## 5.18 ACCESS TO PC BOARDS.

### WARNING

Removal of covers exposes potentially lethal voltages. Avoid contact with internal electrical connections while unit is connected to AC Power source.

5.19 To remove top and bottom covers, proceed as follows:

- a. Remove power cord.

### WARNING

The power supplies are still active as long as the power cord is plugged into the power AC source.

- b. Loosen the four captive screws, one at each corner of the top cover and remove the top cover.
- c. Turn the counter upside down. Loosen the four captive screws on the bottom cover and remove the bottom cover.

## 5.20 PCB REMOVAL.

5.21 When removing the printed circuit board for replacement, repair, and servicing, always remove the AC power cord before disassembly. Refer to figure 5.23, page 5-15 for assembly location.

## 5.22 RF Assembly (figure 6.12 or 6.14).

- a. Remove the six #4 phillips-head screws around the outer edge of the assembly.
- b. Disconnect the two subminiature RF connectors.
- c. Disconnect P10 at the rear of the counter.
- d. On instruments having option 030, remove the five #4 screws holding the RF shield on the component side. Remove shield.

### CAUTION

The R.F. assembly is very sensitive to component movement. Do not move any components or recalibration will be necessary.

## 5.23 Signal Conditioning Assembly (figure 6.1).

- a. Remove the trigger level knobs and the input range knobs.
- b. Remove the two #6 phillips-head screws on the top of the signal conditioner and one #6 phillips-head screw on the bottom.
- c. Remove the subminiature R.F. connectors.
- d. Remove the two #6 phillips-head screws holding cable clamps on the cable between the signal conditioner and P9. Remove P9 and remove the assembly.
- e. To service the attenuator switch, remove the four #4 phillips-head screws located at each corner of the printed circuit board. The printed circuit board can be moved away from the switch assembly for servicing.

## 5.24 Readout Assembly (figure 6.5).

- a. Remove the interconnection printed circuit assembly from J4.
- b. Remove P1 at the left rear of the assembly.

- c. Remove P5 and the FUNCTION knob at the right front side.
- d. Remove the seven #6 phillips-head screws (one in the center and six around the perimeter of the board). The Readout assembly can now be removed.

### **5.25 Switch Board Assembly (figure 6.3).**

- a. Remove the interconnection printed circuit assembly from J2.
- b. Unscrew the subminiature RF connectors from the Signal Conditioning assembly and the RF assembly.
- c. Remove P3 from J3.
- d. Remove the six #6 phillips-head screws, two in the center and four around the perimeter of the printed circuit board. Remove the switch board assembly.

### **5.26 COMPONENT REPLACEMENT.**

5.27 When replacing a circuit board component, use a low heat soldering iron (25 watt). Heat must be used sparingly as damage to the circuit foil may result. Plated-thru holes may be cleaned with a solder remover while heat is applied. The connection should be cleaned with a cleaning solution after the component removal and replacement.

### **5.28 Integrated Circuit Replacement.**

5.29 Integrated circuits can be unplugged and substituted without soldering or assembly removal. The use of special tools to remove IC is not recommended. To remove an IC, place both thumbs on top of the IC and both index fingers at the ends of the IC. Gently rock the IC upward in small steps. Do not "pop" it out in one motion. To replace an IC, be sure the notched end points the same direction as the other ICs on the board. Straighten any bent pins. Align the pins on the IC with the holes in the socket and press the IC in firmly using one or two fingers.

### **5.30 Identification of Parts.**

5.31 All parts are listed in the parts list, Section 7, by assembly. Reference designators are called out on the schematic and can be found on the layout drawings. The Dana part number and description are given in the parts list. All integrated circuits used in the counters are standard 7400 series TTL and ECL that can be purchased from your local supplier. Special parts may be obtained from Dana by writing or calling Product Service at 714-833-1234 collect in California.

### **5.32 Parts Location.**

5.33 The integrated circuits on the Readout and Switch board assemblies are layed out on a grid pattern. Looking at the readout or switch board from the front, the ICs are numbered across the board from left to right, 1 through 12; top to bottom, A through F. Other components are designated by circuit and can be located by the schematic and layout drawing.

### **5.34 TROUBLESHOOTING.**

5.35 This section describes methods for identifying counter troubles and determining the specific corrective action that should be taken. Familiarity with the Operation (Section 3) and Theory of Operation (Section 4) makes troubleshooting easier.

5.36 A malfunction can be rapidly defined to one of four categories.

- a. Apparent trouble which is really a misplaced control setting or an erratic external signal.
- b. Visual damage such as printed circuit board broken, etc.
- c. Analog trouble which requires troubleshooting and component replacement.
- d. Digital trouble which requires troubleshooting and IC replacement.

5.37 Repairs which require replacement of soldered-in components can be accomplished rapidly, but caution should be taken against soldering with improper procedures. Solder damage to the printed circuit boards is not covered by Dana's warranty.

### **5.38 Apparent Troubles.**

5.39 Apparent troubles are those which appear to be equipment malfunctions, but are really controls which are misadjusted.

5.40 The counter will not operate if a function is incorrectly selected. For instance, if the unknown frequency is connected to input C and FREQ A function is selected, there will be no reading. Be sure the FUNCTION switch is in the proper mode. If the function has been changed, depress RESET to start a new reading in the new function.

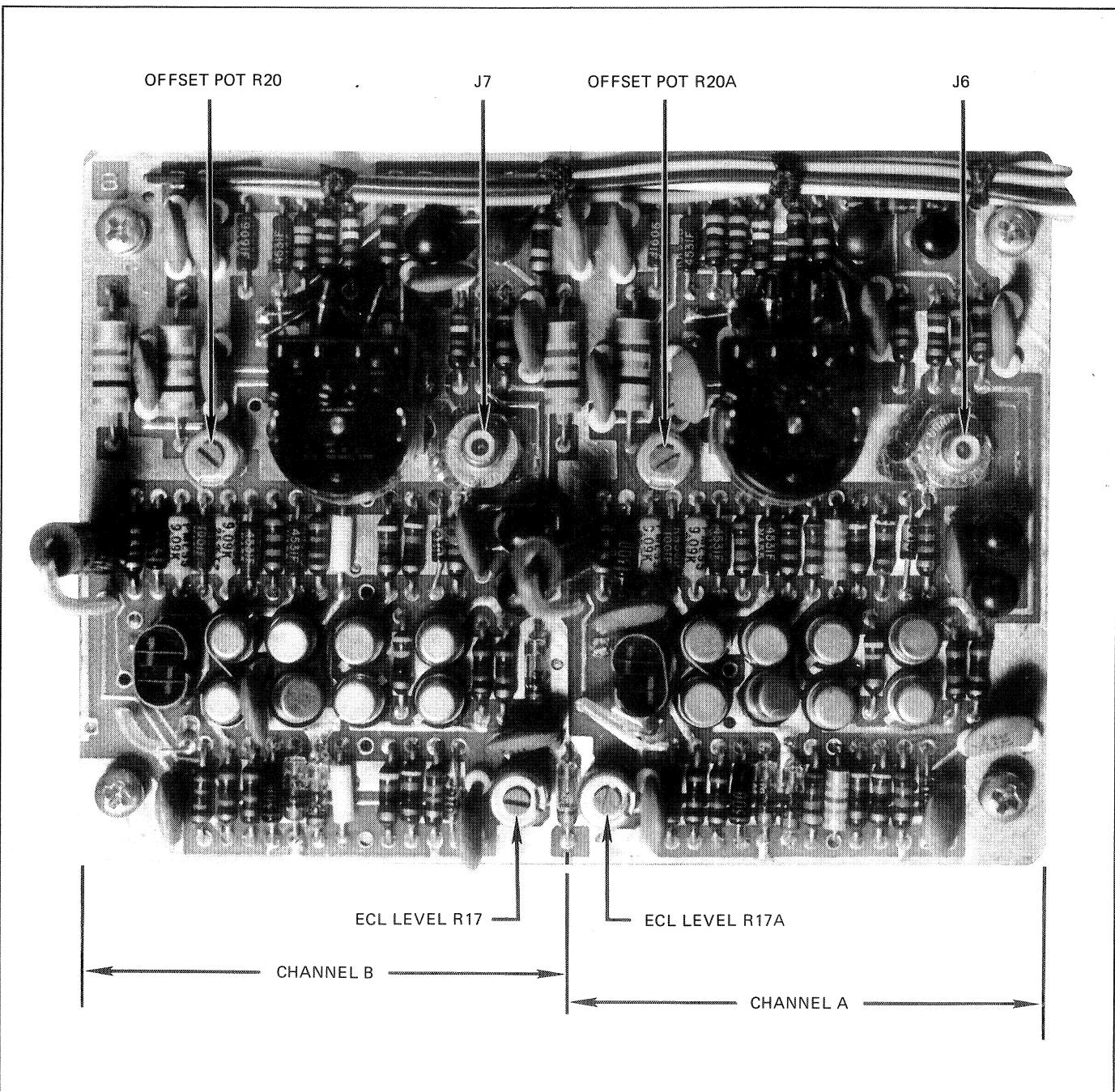


Figure 5.3 - Signal Conditioning Adjustments

**Table 5.3 - Front Panel Symptoms**

Type of Problem	Refer to Paragraph:
Readout	5.49
Remote Operation	5.64
Self-Check Mode	5.68
Frequency A Mode	5.70
Period Mode	5.73
Period Average Mode	5.75
Frequency C (Not in 8010B)	5.77
Totalize Mode	5.80
Time Interval Mode	5.82
A/B (Ratio) Mode	5.85
Time Interval Average Mode	5.88

5.41 If the input voltage range or trigger level are improperly set, inputs A or B will not operate. Be sure that a measurable signal is present and that controls are set properly for that signal.

5.42 When input C is used (not in 8010B), the automatic gain control will inhibit readings of signals which are less than 50 mV and greater than 1V RMS. Signals will be inhibited if they are outside the measurable band (1.0 MHz to 550 MHz). With Option 030, the automatic gain control will inhibit readings of signals which are less than 1 mV and greater than 1V RMS. Signals will be inhibited if they are outside the measurable band for Option 030 (10 MHz to 500 MHz).

5.43 Due to the sensitivity of input C, open leads which might act as an antenna can cause improper readings. If open leads or probes must be used, it may be necessary to insert a low-pass filter at the counter input to discriminate against unwanted signals received through radiation. Unshielded input signals can cause unwanted signals to override the desired signal. The proper operation of input C can be verified by connecting a signal generator directly to the counter through a shielded 50-ohm terminated cable. Once proper counter operation has been verified, unwanted external signals can be attenuated with a low-phase filter.

#### **5.44 Visual Check.**

5.45 A possible source of malfunction could be short or open circuits which disable portions of the counter or load down the power supply, or both. Often these short-circuits can be located by visual inspection. A quick visual check of the counter with the covers removed may reveal foreign

metal parts, frayed cable braid, discolored components, etc. which can be easily corrected. Visual checks can be more meaningful after the trouble has been localized.

5.46 Open circuits can also be located visually. Examine connector and wire harnesses for obvious breakage or opens.

#### **5.47 Front Panel Symptoms.**

5.48 Localize the trouble to one of the categories listed in table 5.3; then proceed to the appropriate paragraph and follow the suggested procedure.

#### **5.49 READOUT INOPERATIVE.**

5.50 If the readout tubes and annunciators do not light, a failure in the 150V supply is indicated. Check the line fuse. It should be .75 amp, 3 AG. If in doubt, measure the AC source at the power transformer T101 to assure that power is getting to the counter. Check the 150-volt supply as follows.

- a. Turn power off; remove the power cord at the rear of the counter. The supplies are still active even with the power switch turned off. Remove the top cover and reconnect the power cord.
- b. Connect a voltmeter to either side of resistor R60, 3.9K, 3W (figure 6.5). Connect the other lead of the voltmeter to ground (negative side of capacitor C7). The voltage should read about 150 volts DC.
- c. Note the action that occurs when the DISPLAY TIME switch is moved clockwise from the PWR OFF position. If the voltage goes very low or to zero, there is a short in the 150V line. If no voltage is present at either side of R60, check the following: R61 (located under C6), C5, CR5 through CR8, and T101.
- d. Remove P1 and check for 180 volts RMS AC at points P1-E (blue transformer lead) and P1-D (violet transformer lead).
- e. If the high voltage is still not present, check the wire harness for opens or shorts. If no opens or shorts are found, T101 may be defective.
- f. If the high voltage is present, reconnect P1 and recheck the 150 volt lines. If the 150 line loads down, locate and eliminate the short on the readout board.

## 5.51 READOUT TUBE BLURRING.

5.52 If all readout tubes blur, a faulty +5-volt supply voltage is indicated. The 5-volt supply is affected by the other power supplies, so they must all be checked.

5.53 Series regulator transistors for the +5-volt and  $\pm 18$ -volt supplies are mounted on a heatsink on the rear panel. A short to ground in the -18-volt supply turns off the +5-volt and +18-volt supplies. Instruments equipped with Option 200 have a separate +28-volt supply and regulator. A short in this supply also affects the other voltages. It can be measured at J4-X.

5.54 Check the power supply voltages at the points listed below. Refer to figure 6.6 for voltage levels within the power supply.

Power Supply	Measurement Point (figure 6.5)
+5V	J4-20 or CR40 anode
+18V	Cathode of CR40
-18V	Anode of CR22

5.55 If any of the power supply voltages are abnormal, disconnect the load to isolate the trouble to the supply or to the load. If the voltage returns to normal, reconnect the load and selectively unplug the interconnection board, the signal conditioning board, and the prescaler until the source of the overload is located.

5.56 If the trouble appears in only one readout tube, a bad integrated circuit (IC) driver or a bad readout tube is indicated. Driver IC's are 7441's in Row F directly behind the readout tubes. Remove power, and exchange the 7441 behind the bad readout with the neighboring driver. If the trouble moves with the driver (7441), replace the 7441 driver. If the trouble stays when the driver is moved, replace the readout tube. If none of the above solves the problem, inspect the circuit near the tube, driver, or quad latch (7475) for shorts or opens.

## 5.57 ANNUNCIATORS INOPERATIVE.

5.58 The "gate" and units annunciators are located in front of and below the readout tubes (figure 6.5). They are operated from the +150-volt and +5-volt power supplies. If none of the annunciators light, the power supply is probably faulty. Perform the power supply checkout procedures described in paragraph 5.49.

5.59 If the GATE annunciator does not operate, proceed as follows:

- Set DISPLAY TIME counterclockwise, just short of the PWR OFF position.
- Set FUNCTION switch to the CHECK mode.
- Depress the 100 ms TIMEBASE switch (the GATE light should flash at approximately 130 ms intervals).
- With an oscilloscope, check at the cathode of CR1 for a pulse going from zero to +4.0 volts. If the pulse is not present, check at J2-4 (see circuit, figure 5.4).

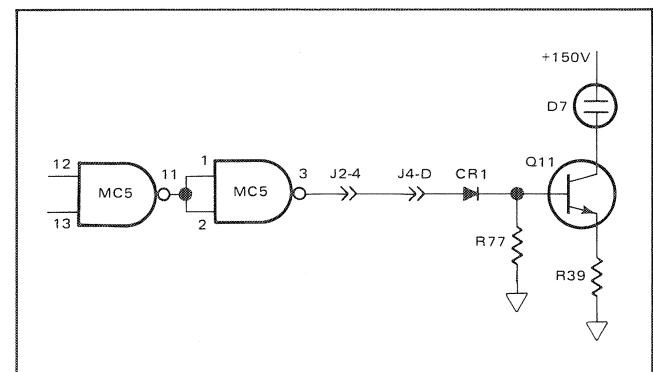


Figure 5.4 - Gate Annunciator

- If the pulse is not present at J2-4, check the control logic on the Switch board assembly. Verify first that a "start" pulse is being generated.

5.60 If one of the units annihilators does not light, refer to table 5.4. In the table, voltage levels at the inputs and output of gates are listed. If a level differs by  $\pm 10\%$  from that listed, the trouble is located between the correct level and the incorrect level. Integrated-circuit drivers in each circuit may be unplugged and exchanged with one of the same type known to be good. If a driver becomes shorted, the corresponding annunciator remains "on". If the driver is open, the annunciator remains "off".

## 5.61 DECIMAL POINT MALFUNCTION.

5.62 Should any one decimal point not turn on, perform the following decimal point check:

- Set the FUNCTION switch to FREQ C. Select the 1  $\mu$ s timebase. No decimal point should be lit. If one is lit, try substituting the readout with the one

Table 5.4 - Units Announciators Troubleshooting

Annunciator	Function	Select Timebase/Multiplier	Measurement Point	Normal Level	Figure No.
$\mu$ sec	PERIOD Mode	$1 \mu$ s	E54 MB11-8	$\geq 2.0$ volts	5.5
			MB11-10 MC12-8	$\leq 0.8$ volts	
			MB11-11 MB12-3	$\geq 2.0$ volts	
			MB12-1	$\leq 0.8$ volts	
			MB12-2	$\leq 0.8$ volts	
msec	PERIOD Mode	$10 \mu$ s	E50 MD10-12	$\leq 2.0$ volts	5.6
			MD10-13 MD12-8	$\leq 0.8$ volts	
			MD12-2	$\geq 2.0$ volts	
			MD12-3	$\geq 2.0$ volts	
nsec	PER AVG Mode	$10^6$	E52 MD11-11	$\geq 2.0$ volts	5.7
			MD11-13 MC11-8	$\leq 0.8$ volts	
			MD11-12	$\geq 2.0$ volts	
			MD11-8	$\geq 2.0$ volts	
sec	PERIOD Mode	10 ms	E51 MD11-3	$\geq 2.0$ volts	5.8
			MD11-1 MC11-6	$\leq 0.8$ volts	
			MC11-2	$\geq 2.0$ volts	
			MC11-3	$\geq 2.0$ volts	
KHz	FREQ A Mode	10s	E53 MB12-8	$\geq 2.0$ volts	5.9
			MB12-9 MB12-6	$\leq 0.8$ volts	
			MB12-4	$\geq 2.0$ volts	
			MB12-5	$\geq 2.0$ volts	
MHz	FREQ A Mode	1s	E49 MD10-2	$\geq 2.0$ volts	5.10
			MD10-1 MC9-8	$\leq 0.8$ volts	
			MC9-1 MA12-6	$\geq 2.0$ volts	
			MA12-5 MB8-3	$\geq 2.0$ volts	
			MB8-1	$\geq 2.0$ volts	
			MB8-2	$\geq 2.0$ volts	
			MC9-13	$\geq 2.0$ volts	

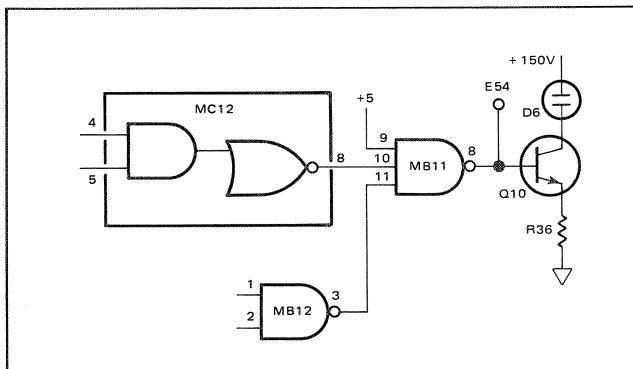


Figure 5.5 - "μsec" Annunciator

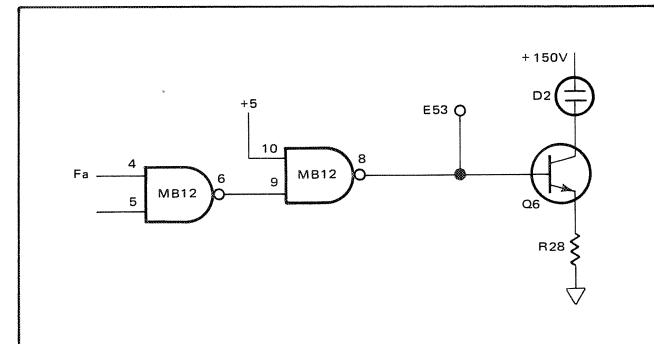


Figure 5.9 - "KHz" Annunciator

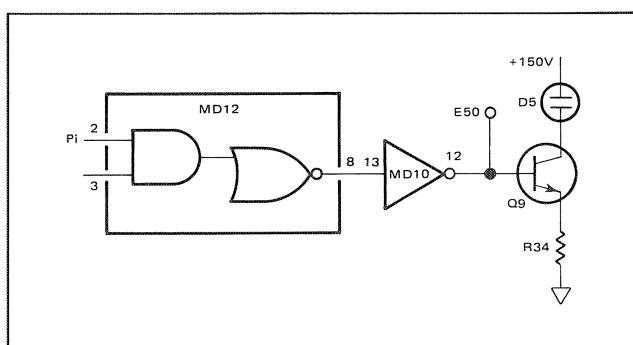


Figure 5.6 - "msec" Annunciator

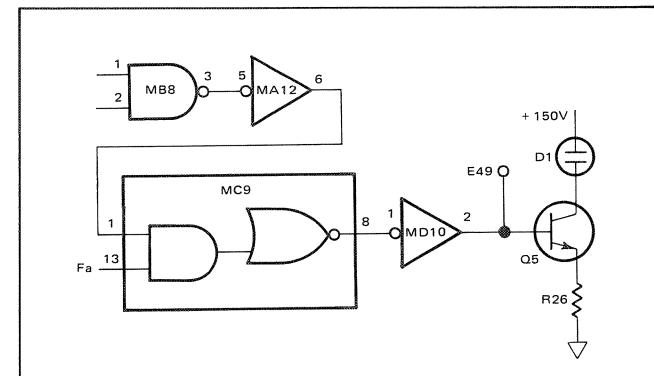


Figure 5.10 - "MHz" Annunciator

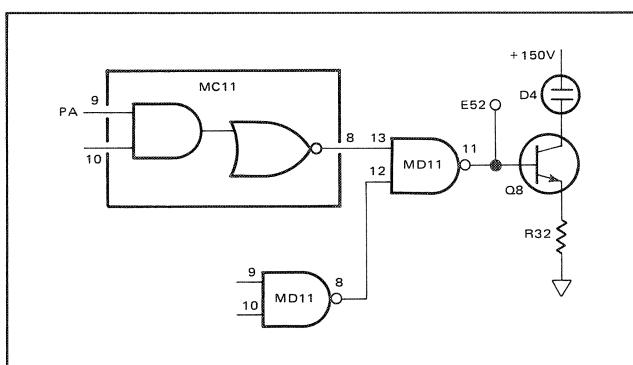


Figure 5.7 - "nsec" Annunciator

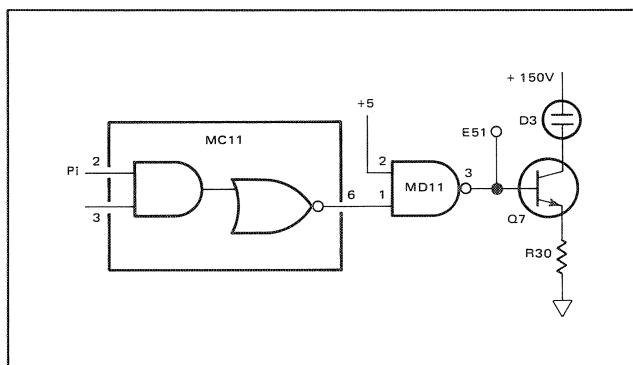


Figure 5.8 - "sec" Annunciator

next to it. Each decimal point is driven by a transistor which, if open or shorted, causes a decimal point to remain off or on continuously.

- b. Depress the 10  $\mu$ s to 100s TIMEBASE switches; the decimal point should light as shown in table 5.5.

- 5.63 Procedures for signal tracing through the DP logic are listed in table 5.6.

Table 5.5 - Decimal Point Placement

Timebase	Decimal Point Display								
	V9	V8	V7	V6	V5	V4	V3	V2	V1
10 $\mu$ s	0	0	0	0	0	0	0	0	.0
100 $\mu$ s	0	0	0	0	0	0	0	0	.0
1 ms	0	0	0	0	0	0	.0	0	0
10 ms	0	0	0	0	0	.0	0	0	0
100 ms	0	0	0	0	.0	0	0	0	0
1s	0	0	0	.0	0	0	0	0	0
10s	0	0	.0	0	0	0	0	0	0
100s	0	.0	0	0	0	0	0	0	0
	↑	DP8	DP7	DP6	DP5	DP4	DP3	DP2	DP1

Models with Option 004 (9th digit)

Table 5.6 - Troubleshooting Procedure - DP Logic

Decimal Pt.	Select Timebase	Measurement Point(s)	Normal Level	Figure No.
DP1	10 $\mu$ s	E70 MC7-6	$\geq$ 2.0 volts	5.11
		MC7-5 MA9-8	$\leq$ 0.8 volts	
		MA9-4 MA9-5	$\geq$ 2.0 volts	
DP2	100 $\mu$ s	E71 CR26 anode CR27 anode	$\geq$ 2.0 volts	5.12
		MC7-11	$\geq$ 2.0 volts	
		MC7-12 MC8-6	$\geq$ 2.0 volts	
		MC7-13 MB9-8	$\leq$ 0.8 volts	
		MB9-4 MB9-5	$\geq$ 2.0 volts	
DP3	1 ms	E72 MB7-12	$\geq$ 2.0 volts	5.13
		MB7-13 MC9-6	$\leq$ 0.8 volts	
		MC9-4 MC9-5	$\geq$ 2.0 volts	
DP4	10 ms	E73 MB7-6	$\geq$ 2.0 volts	5.14
		MB7-5 MA10-8	$\leq$ 0.8 volts	
		MA10-4 MA10-5	$\geq$ 2.0 volts	
DP5	100 ms	E74 MB7-4	$\geq$ 2.0 volts	5.15
		MB7-3 MB10-8	$\leq$ 0.8 volts	
		MB10-2 MB10-3	$\geq$ 2.0 volts	
DP6	1s	E75 MC7-8	$\geq$ 2.0 volts	5.16
		MC7-9 MC10-6	$\leq$ 0.8 volts	
		MC10-2 MC10-3	$\geq$ 2.0 volts	
		MC8-8 MC7-10	$\geq$ 2.0 volts	

Table 5.6 - Troubleshooting Procedure - DP Logic (continued)

Decimal Pt.	Select Timebase	Measurement Point(s)	Normal Level	Figure No.
DP7	10s	E76 MB7-2	$\geq 2.0$ volts	5.17
		MB7-1 MC10-8	$\leq 0.8$ volts	
		MC10-1 MC10-13	$\geq 2.0$ volts	
		MA12-12	$\geq 2.0$ volts	
DP8	100s	E77 MB7-10	$\geq 2.0$ volts	5.18
		MB7-11 MC8-3	$\leq 0.8$ volts	
		MC8-1 MC8-2	$\geq 2.0$ volts	
		MA7-10	$\geq 2.0$ volts	

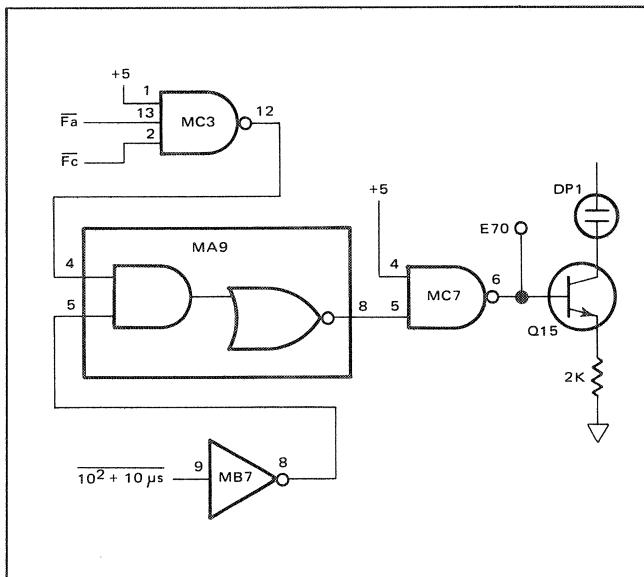


Figure 5.11 - DP1 Decimal Point Logic

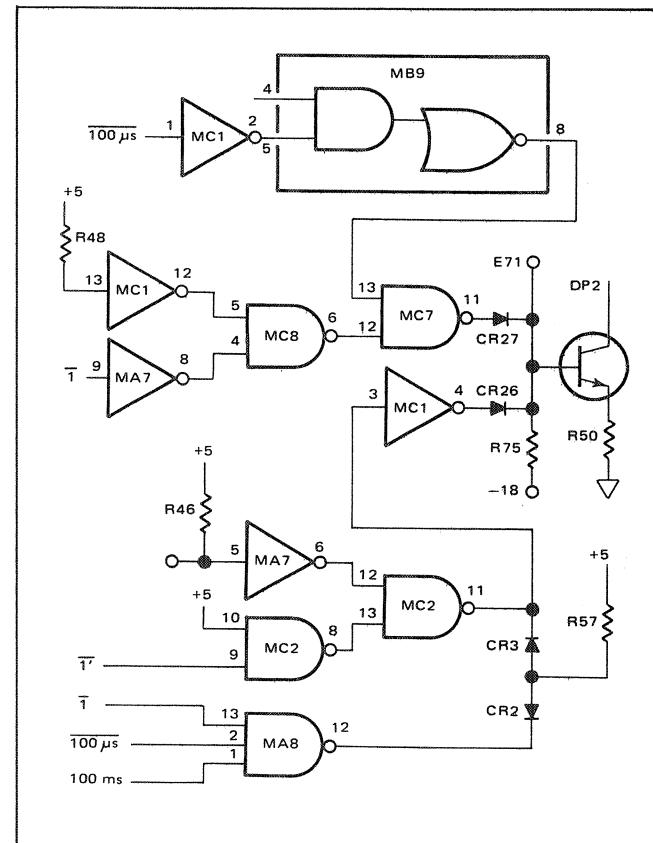


Figure 5.12 - DP2 Decimal Point Logic

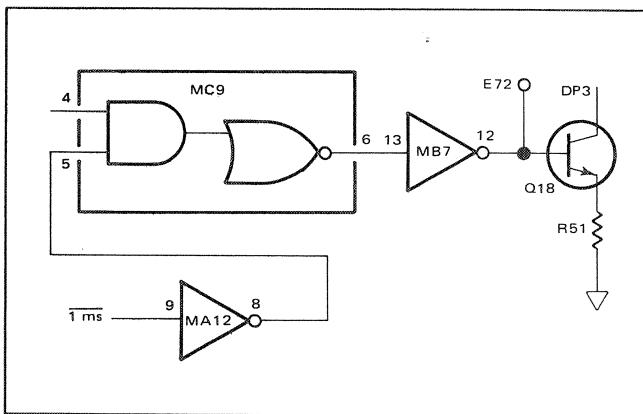


Figure 5.13 - DP3 Decimal Point Logic

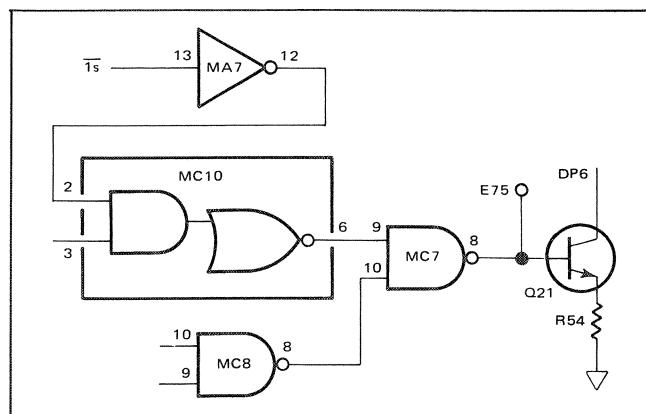


Figure 5.16 - DP6 Decimal Point Logic

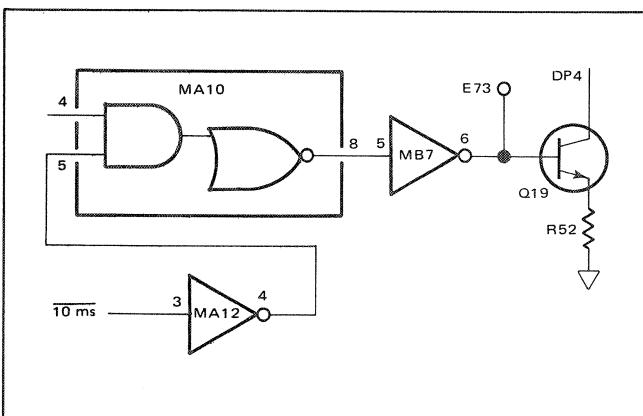


Figure 5.14 - DP4 Decimal Point Logic

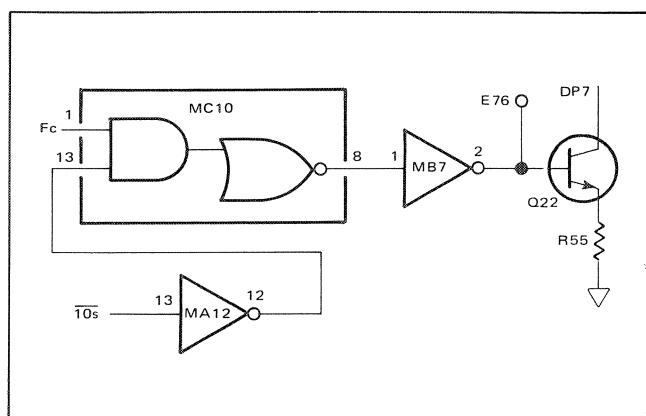


Figure 5.17 - DP7 Decimal Point Logic

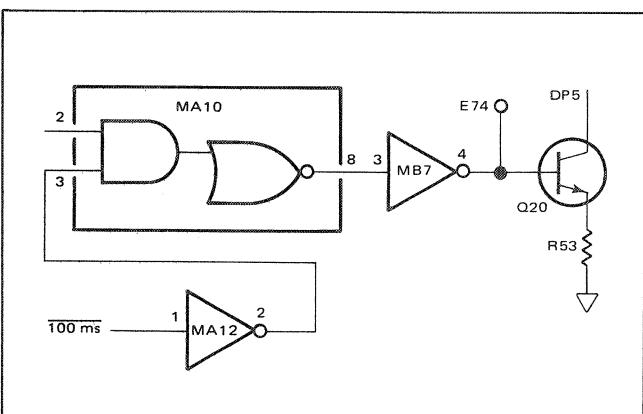


Figure 5.15 - DP5 Decimal Point Logic

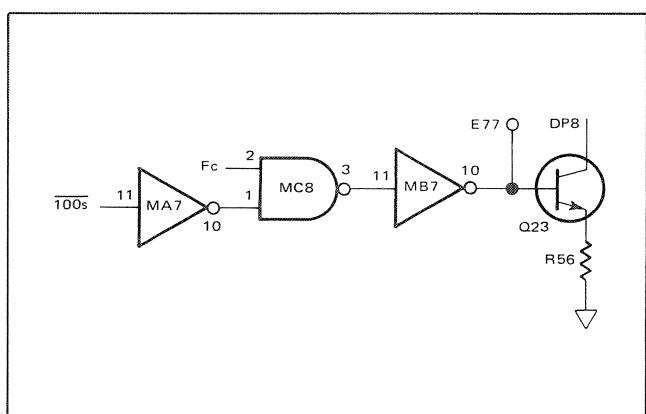


Figure 5.18 - DP8 Decimal Point Logic

## 5.64 Faulty Remote Operation.

5.65 Normally, problems occurring with the remote programming option occur also in local operation. Verify that transistor Q7 on the Switch board turns off with REMOTE selected. If Q7 operates properly, a malfunction can be traced by following the procedures for troubleshooting a specific operating mode. Also verify that there are no opens or wiring errors in the external circuits.

## 5.66 Faulty Operation In One Mode.

5.67 Figures 5.25 through 5.33 show the signal flow through the instrument in each mode of operation. Logic levels are given at significant check points to assist in signal tracing.

## 5.68 CHECK MODE (Figure 5.25).

5.69 In Check mode, the reference oscillator frequency is routed to the counting decades and to the timebase decades.

## 5.70 FREQUENCY A MODE (Figure 5.28).

5.71 The signal for Frequency A mode is routed through the Signal Conditioning assembly where the trigger slope and trigger point are selected. Attenuation of the signal also takes place in the attenuator section of the signal conditioning. Frequency A ( $f_a$ ) is routed to the counting decades. The time that the counting decades are allowed to count is controlled by the Reference Oscillator, Timebase Decades, and the Control Logic. Be sure that the FUNCTION switch is positioned to FREQ A and that the range and trigger level controls are set correctly.

5.72 Connect an oscilloscope to E2 and E1 on the Switch board assembly. Connect a signal to the Frequency A input and adjust the counter accordingly. An ECL square wave should be seen varying between 3.4V and 4.2 volts dc. Try moving the trigger level control over its range. If no signal is found, the trouble is in the Attenuator or Signal Conditioning Module. Refer to the schematic of the Signal Conditioning module for troubleshooting (figure 6.2).

## 5.73 PERIOD MODE (Figure 5.26).

5.74 The signal in the Period mode is routed through the Attenuator and the Signal Conditioning assembly where the trigger slope and trigger level are selected. The signal ( $f_a$ ) is

routed to the Control Logic which controls the time that the counting decades are allowed to count the Reference Oscillator or a frequency division of the Reference Oscillator. Follow the procedure in paragraph 5.72. If the signal is present at E2 and E1, refer to the Period Signal Flow schematic for gate levels and signal flow.

## 5.75 PERIOD AVERAGE MODE (Figure 5.27).

5.76 The signal in Period Average mode is routed through the Attenuator to the Signal Conditioning assembly and to the Multiplier Timebase Decades. The output of the Timebase Decades ( $f/n$ ) goes to the start/stop logic and on to the Control Logic which controls the counting decades. The Reference Oscillator is routed to the fast counting decades. The counting decades are controlled by  $\Delta t$ .  $\Delta t$ 's time is determined by  $f_a$  and the multiplier selected on the front panel. Follow the procedure in paragraph 5.72. If the signal is present at E2 and E1, refer to the Period Average Signal Flow schematic for gate levels and signal flow.

## 5.77 FREQUENCY C MODE (Figure 5.29, not in 8010B).

5.78 Frequency C is much like Frequency A operation. The signal is connected to the Frequency C input and routed into the Frequency C RF Assembly. The signal is amplified. The amplification is controlled by an automatic gain control circuit (AGC). The signal is divided by two through a discrete flip-flop and divided again by two through a ECL flip-flop. The signal is routed to E4 and E3 on the Switch board assembly. The signal ( $f_c$ ) goes to a ECL gate and to the counting decades. The Reference Oscillator is gated through to a divide-by-four flip-flop to the Timebase Decades.

5.79 To determine if the Frequency C signal reaches the Switch board, connect an oscilloscope to E4 and E3 on the Switch board. Set the FUNCTION switch to FREQ C. Connect a signal to Input C. A ECL square wave should be seen on the oscilloscope varying between 3.4V and 4.2 volts dc. If no signal is found, the trouble is in the Frequency C RF assembly. Refer to figure 6.12 or 6.13 or figures 6.14 and 6.15 for Option 030 (1 mV, 10 MHz – 500 MHz) for the schematic of the RF assembly.

## 5.80 TOTALIZE MODE (Figure 5.30).

5.81 The signal in the Totalize mode is routed through the A input to the Attenuator and Signal Conditioning Module where the trigger level and slope are selected. The output of the Signal Conditioner is gated to the counting decades. The counting decades are controlled by the manual start/stop circuit which develops  $\Delta t$ , the gate time for the

count. The input signal divided by 10 ( $f_a/10$ ) is routed to the Timebase Decades and to the scaled output connector for external use.

#### 5.82 TIME INTERVAL MODE (Figure 5.31).

5.83 The signals in the Time Interval mode are routed through the A and B inputs to the A and B Signal Conditioning Modules. The Signal Conditioning circuits determine the trigger points and trigger slope. The output of A is at E2 and E1 on the Switch board. The output of B is at E6 and E5 on the Switch board. The Reference Oscillator is gated to the Multiplier Timebase Decades. The Multiplier Timebase Decades are gated to the counting decades. The counting decades are controlled by the Control Logic which is controlled by the stop/start logic. The signal from input A determines the start time and the input B signal determines the stop time. The start and stop circuits define the gate time.

5.84 Verify that the input controls are set correctly. Observe E2 and E1, and E6 and E5 to determine that a square wave pulse is being generated at the correct time. If a signal is not present, refer to the Signal Conditioning schematic, figure 6.2.

#### 5.85 A/B (RATIO) MODE (Figure 5.32).

5.86 The signals in the Ratio mode are routed through the Inputs A and B. The signal from Input A goes to the Attenuator and Signal Conditioning circuits where the trigger level and slope are selected. The output of the A Signal Conditioner ( $f_a$ ) is routed to the counting decades. The output of B Signal Conditioner ( $f_b$ ) is routed to the Multiplier Timebase Decades and to the Control Logic. The Control Logic starts and stops the counting decades.

5.87 Verify that there is a signal at the output of the A Signal Conditioner (E2, E1). Verify that there is also a signal at the output of the B Signal Conditioner (E6, E5). If either of these signals are missing, refer to the Signal Conditioner schematic, figure 6.2.

#### 5.88 TIME INTERVAL AVERAGE MODE (Figure 5.33).

5.89 The signals in the Time Interval Average mode are routed through Inputs A and B. The signals are attenuated at the Attenuator. The trigger level and the slope are selected in the A and B signal conditioners. Signals  $f_a$  and  $f_b$  are routed to the Switch board at points E2 and E1 (A) and E6 and E5 (B). Signal  $f_a$  is routed to two type-D flip-flops. The signal is synchronized with the Reference Oscillator. When signal  $f_a$  goes high, the reference clock enables the counting decades. Signal  $f_b$  is synchronized with the Reference Oscillator and disables the reference clock to the counting decades at the end of the incoming signal. Signal

$f_b$  also produces  $f_b$  SYN which goes to the Timebase Decades. Signal  $f_b$  SYN is generated once per measurement period. Thus, the Timebase Decades count  $f_b$  SYN. Depending on the multiplier selected, 1 to  $10^9$ , one measurement or 1000 million measurements will be made and averaged.

5.90 Verify that the signals  $f_a$  and  $f_b$ , at ECL levels, appear at points E2 and E1 (A), and E6 and E5 (B). If a signal is not present, check the controls for proper setting. Refer to figure 6.2 for schematic of the Signal Conditioner. If both signals  $f_a$  and  $f_b$  are present, refer to the signal flow schematic.

#### 5.91 Troubleshooting The Signal Conditioning Assembly.

##### **WARNING**

Removal of covers exposes potentially lethal voltages. Avoid contact with internal electrical connections while unit is connected to AC Power source.

5.92 For disassembly refer to paragraph 5.23. Follow the calibration procedures in paragraphs 5.14 and 5.15 (dual channel). If this does not reveal the problem, refer to the schematic, figure 6.2. Voltage levels and signal level are given on the schematic.

5.93 Channel A and channel B (except on 8020B) are schematically the same. The reference designators are suffixed with an "A" in the channel A circuits. To verify that Q1 and Q10 are matched to each other, proceed as follows:

- a. Ground the bases of Q4 and Q8.
- b. Measure between the bases of Q2 and Q9. Verify the operation of R20; the voltage should vary from negative, through zero, to positive. If this voltage range cannot be obtained, either Q1 and Q10 are not matched or there is a component failure in the circuit.

5.94 The following pairs of transistors in this circuit are matched as indicated.

- Q4 and Q8;  $V_{be}$  (base-to-emitter voltage)
- Q2 and Q9;  $V_{be}$  (base-to-emitter voltage)
- Q1 and Q10;  $R_{ds}$  (resistance, drain-to-source)

#### 5.95 Troubleshooting The RF Assembly.

5.96 For disassembly, refer to paragraph 5.22. Note: *Do not move any components unless that component is known to be defective.* The RF Assembly is very sensitive to component location. Recalibration will be required if a component is replaced in a critical area. Voltage levels are

given on the schematic figures 6.13 or 6.15. However, it is recommended that the RF assembly be returned to Dana's Product Service for repair and calibration.

## 5.97 BASIC LOGIC DEFINITION.

### 5.98 TTL Logic.

5.99 A majority of the integrated circuits used in the 8000B counters are TTL type integrated circuits. TTL circuits operate up to  $\approx 15$  MHz. The basic Nor function is shown in figure 5.19. Logic levels are:

Logical 0:  $\leq .8V$

Logical 1:  $\geq 2.0V$

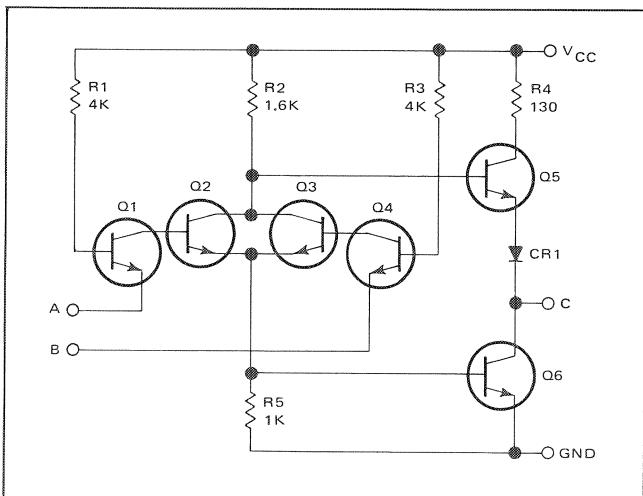


Figure 5.19 - Basic TTL Nor Gate

5.100 The Nor gate is comprised of six transistors. The two input transistors, Q1 and Q4, are used as diode or gates (figure 5.20). Transistors Q2 and Q3 are voltage phase inverters. Transistors Q5 and Q6 form a totem-pole output. The totem-pole circuit has a low output resistance for both a high and low level.

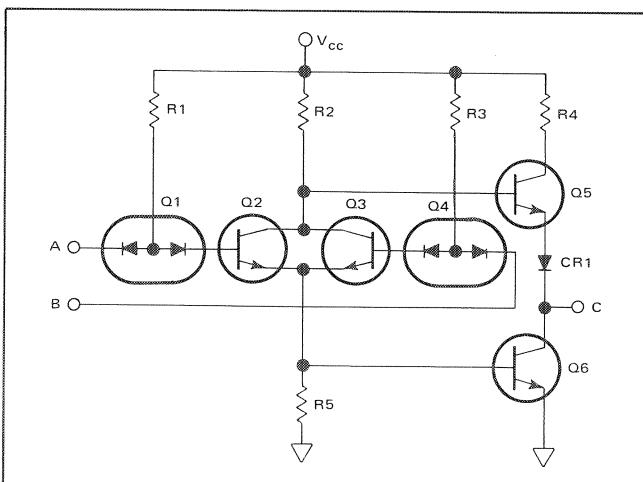


Figure 5.20 - Equivalent Circuit

5.101 Assume a Logical "0" level exists at both A and B inputs. Transistor Q1 and Q4 are conducting. Therefore, the collectors of Q1 and Q4 are at logical "0" level. The logical "0" level from the collectors of Q1 and Q4 are applied to the bases of Q2 and Q3 causing them to turn off. The collectors of Q2 and Q3 are connected together and to the base of Q5. The logical "1" on the base of Q5 causes Q5 to conduct. Output C is connected to the emitter of Q5 via CR1. Diode CR1 prevents an indeterminate output. The output of the Nor gate is two diode drops (1.4V) lower than the base voltages of Q5 or 3.6V.

5.102 Assume a logical "1" level is applied to input A. Base current for Q2 is supplied through R1 and the base-collector junction of Q1. Transistor Q2 is turned on. The collector of Q2 is connected to the base of Q5 and turns Q5 off. The emitter of Q2 is connected to the base of Q6. Q2 supplies base current to Q6 base; therefore Q6 is turned on and output C is low.

5.103 A logical "1" level applied to either or both inputs A or B result in a logical "0" level at output C. The truth table is shown in table 5.7.

Table 5.7 - Truth Table

A	B	C
1	1	0
1	0	0
0	1	0
0	0	1

## 5.104 Emitter Coupled Logic (ECL).

### 5.105 BASIC NOR FUNCTION.

5.106 A number of ECL integrated circuits are used in the counter. ECL circuits are used wherever high-speed switching is required. The basic Nor function is shown in figure 5.21. Logic levels used are:

Logical 0: 3.5V      Logical 1: 4.2V

5.107 The gate is comprised of differential amplifier Q2 and Q3, input transistors Q1 and Q2, and emitter follower output transistor Q4. Transistor Q3 and resistors R3 and R4 form a fixed bias circuit.

5.108 Assume Logical "0" levels exist at both A and B inputs. Transistors Q1 and Q2 are cut off; therefore, the collectors of Q1 and Q2 are at a logical "1" level. The logical "1" level from the collectors of Q1 and Q2 is applied

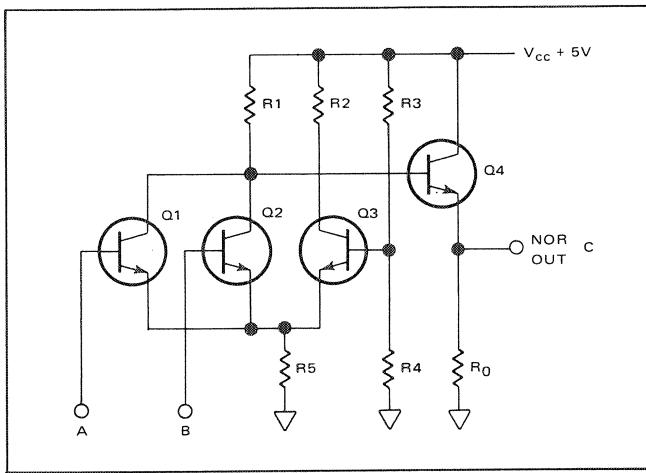


Figure 5.21 - Basic ECL Nor Gate

to the base of Q4, causing Q4 to conduct. The output at the emitter of Q4 is a logical “1” level (output C).

5.109 Assume that a logical "1" level is applied to input A. Transistor Q1 conducts and a logical "0" level results at the Q1 collector due to the drop across R1. The logical "0" level is applied to the base of Q4 causing Q4 to cut off providing a logical "0" level at output C.

5.110 A logical “1” level applied to either or both input A or B results in a logical “0” level at output C. The circuit therefore performs a Nor function; the truth table is shown in table 5.8.

Table 5.8 - ECL NOR Truth Table

A	B	C
0	0	1
1	0	0
0	1	0
1	1	0

### 5.111 DIODE GATE.

5.112 The purpose of a diode gate (figure 5.22) is to control a ECL level signal with a TTL gate. The diode gate is much faster than TTL logic and speed is required in these circuits. Diode CR2 is always in forward conduction with the current provided through resistor R2 from V. The state of CR1 depends on the output of TTL gate. If the TTL gate is high, the CR1 conducts. If the TTL gate is low, then CR1 is reverse-biased and the signal is not transferred from

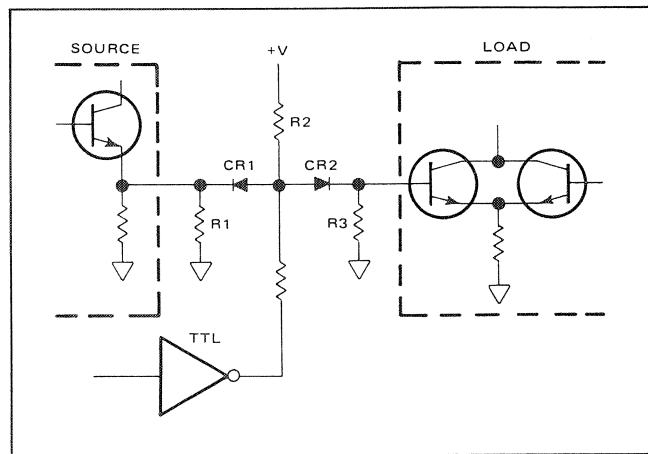


Figure 5.22 - Diode Gate

the source to the load. If the output of the TTL gate and CR1 is forward biased, a low insertion loss signal path is provided between the source and the load. DC levels are maintained between the source and load as shown in table 5.9 due to CR1 and CR2 being connected back-to-back.

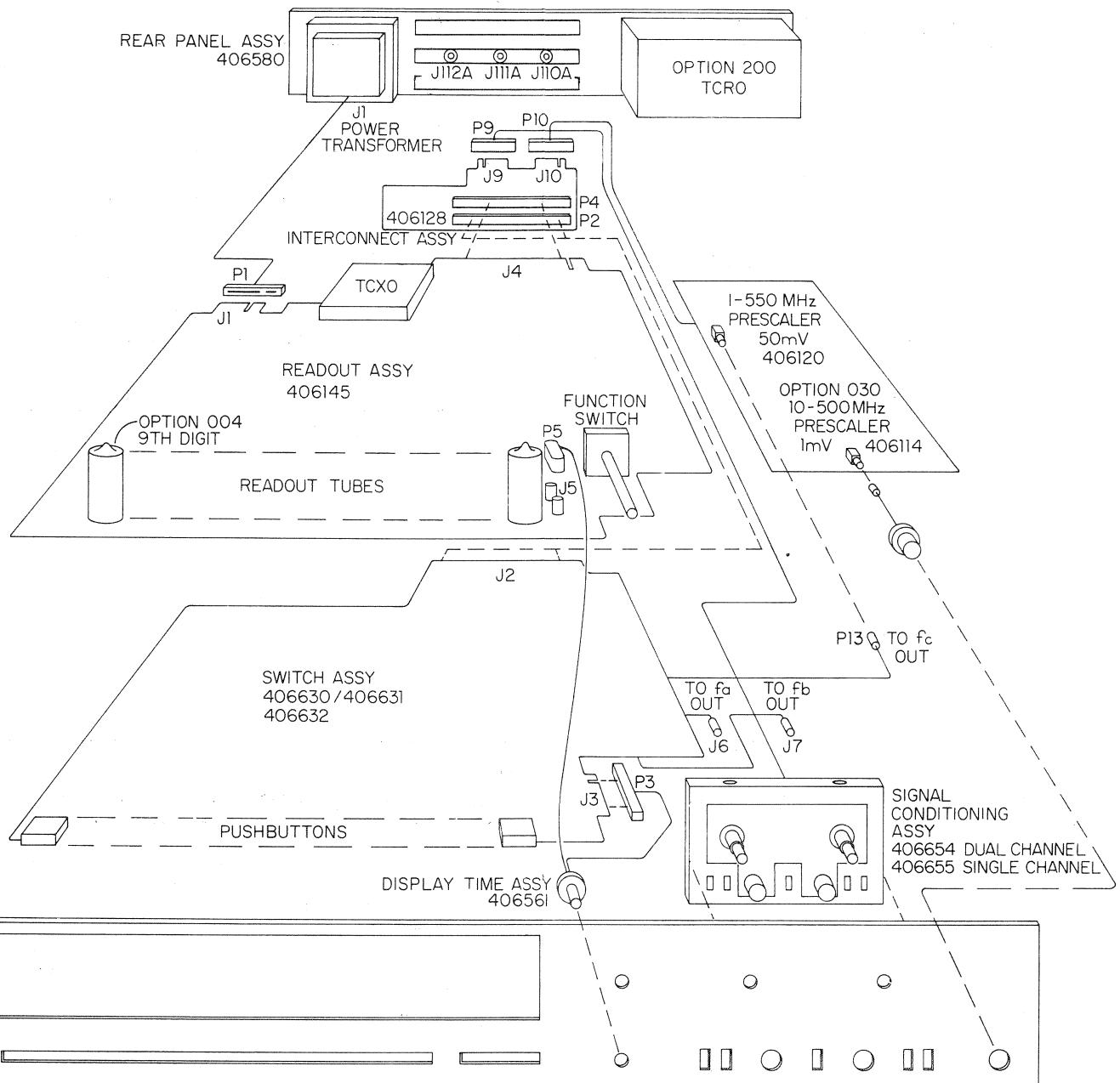
**Table 5.9 - DC Levels**

	TTL Gate High	TTL Gate Low		
V Source Output	3.4	4.2	3.4	4.2
V Load Input	3.4	4.2	3.14	3.14

### **5.113 BOARD REVISION.**

5.114 Every effort is made to keep the manual concurrent with the instrument despite changes to the design, which are an inevitable adjunct of the manufacturing process. The manual is updated and periodically reprinted throughout the year. In between printings, Addendums and Errata Sheets are added to the manual if required to implement the reprinted copy.

5.115 Any design change is accompanied by an updating of a board revision. Such change could be as simple as a revised hole size or as complex as major modifications of the circuitry. The revision of a board is indicated by the letter preceding the assembly number stamped on the board; the revision of the assembly drawing in Section 6 or on an Errata Sheet is indicated by the letter following the assembly number, located below the drawing. Comparing the revision letters can indicate how closely the drawing corresponds to the board.

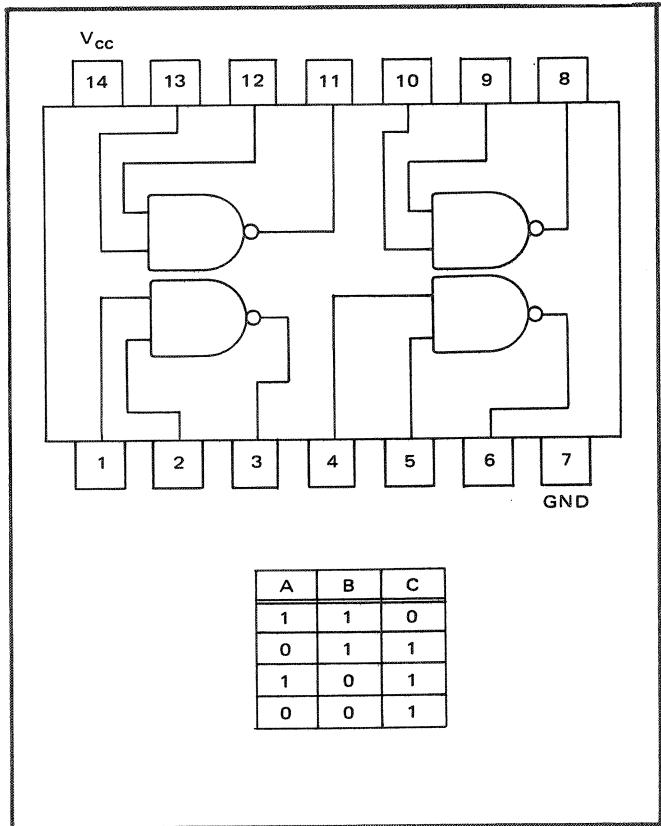


ASSEMBLY NAME	MODEL	
	8010B	8030B
SIGNAL CONDITIONING	406654	406654
SWITCH BOARD	406631	406632
READOUT BOARD	406145	406145
REAR PANEL	406580	406580
550 MHz PRESCALER	NOTE ONLY 1 PRESCALER PER COUNTER	406120
500 MHz PRESCALER OPTION 030		406114
DISPLAY TIME CONTROL	406561	406561
INTERCONNECT BOARD	406128	406128
FRONT PANEL	730552	730555

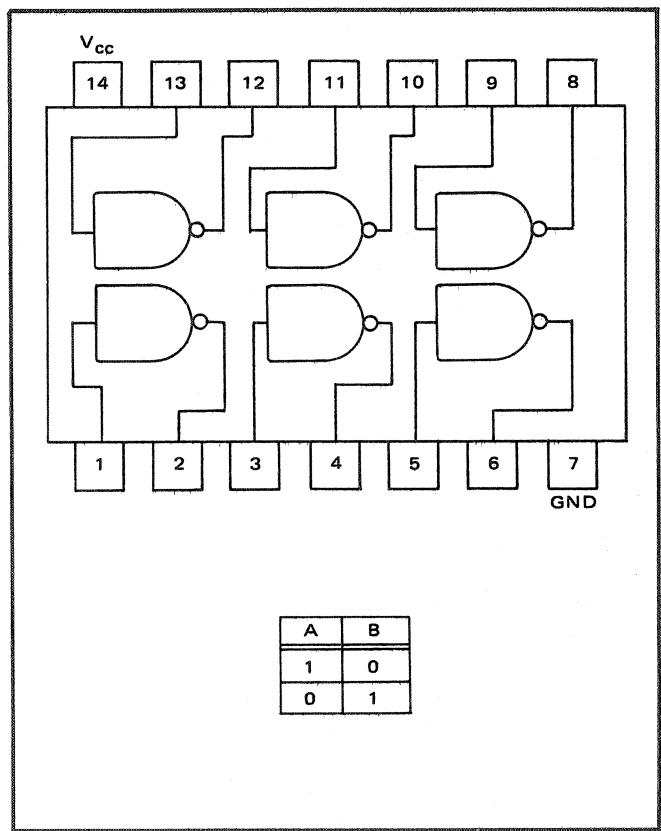
Figure 5.23 - Exploded View

980448-0

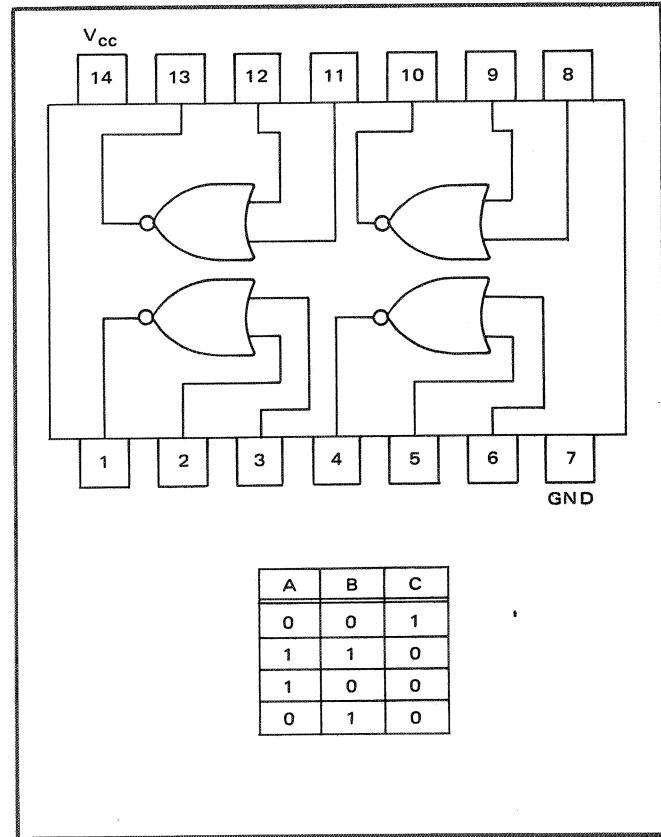
**7400 / 74H00**  
**QUADRUPLE 2-INPUT POSITIVE NAND GATE**



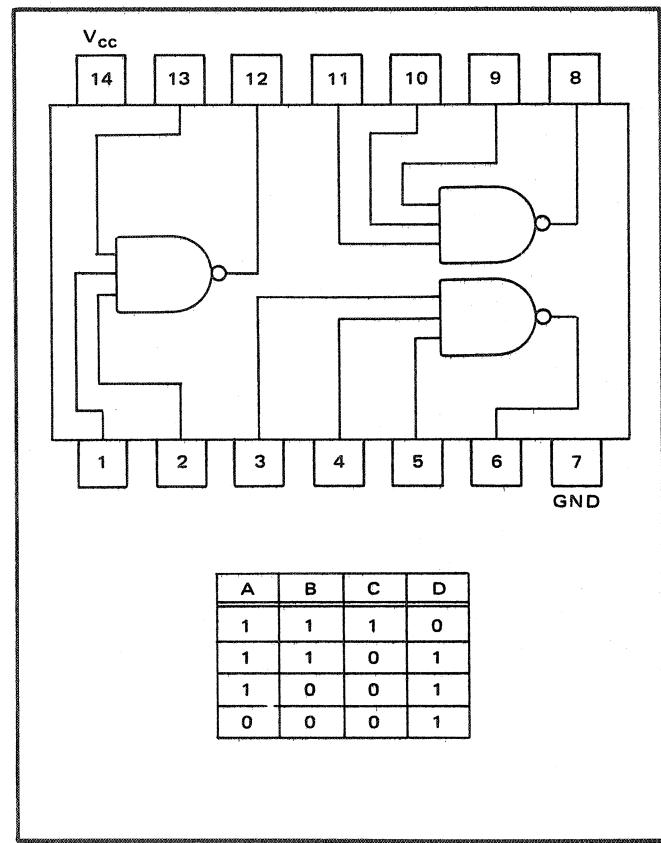
**7404**  
**HEX INVERTER**



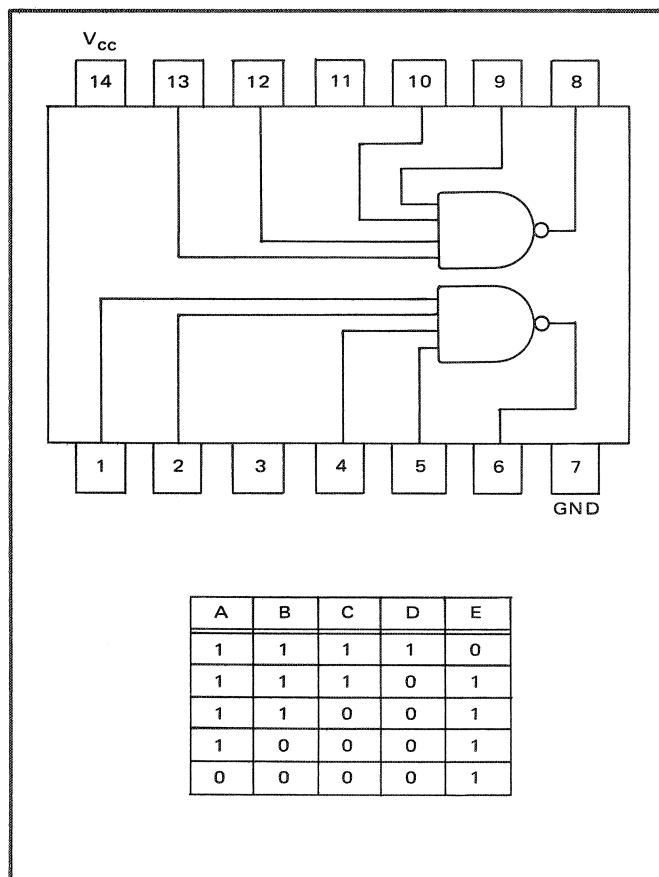
**7402**  
**QUADRUPLE 2-INPUT POSITIVE NOR GATE**



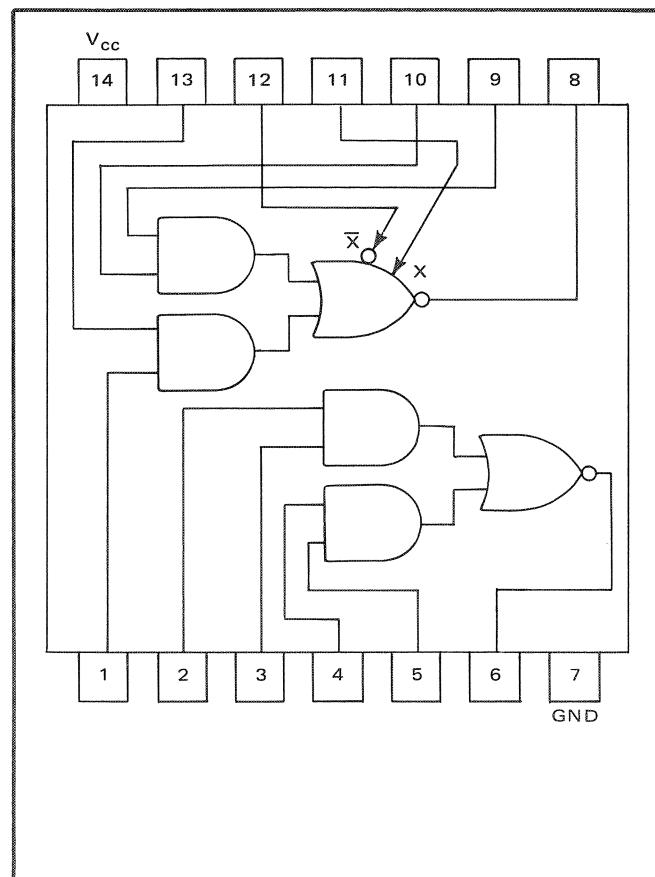
**7410**  
**TRIPLE 3-INPUT POSITIVE NAND GATE**



**7420**  
DUAL 4-INPUT POSITIVE NAND GATE



**7451**  
EXPANDABLE DUAL 2-WIDE 2-INPUT AND-OR-INVERT GATES



**7441**  
BCD-TO-DECIMAL DECODER/DRIVER

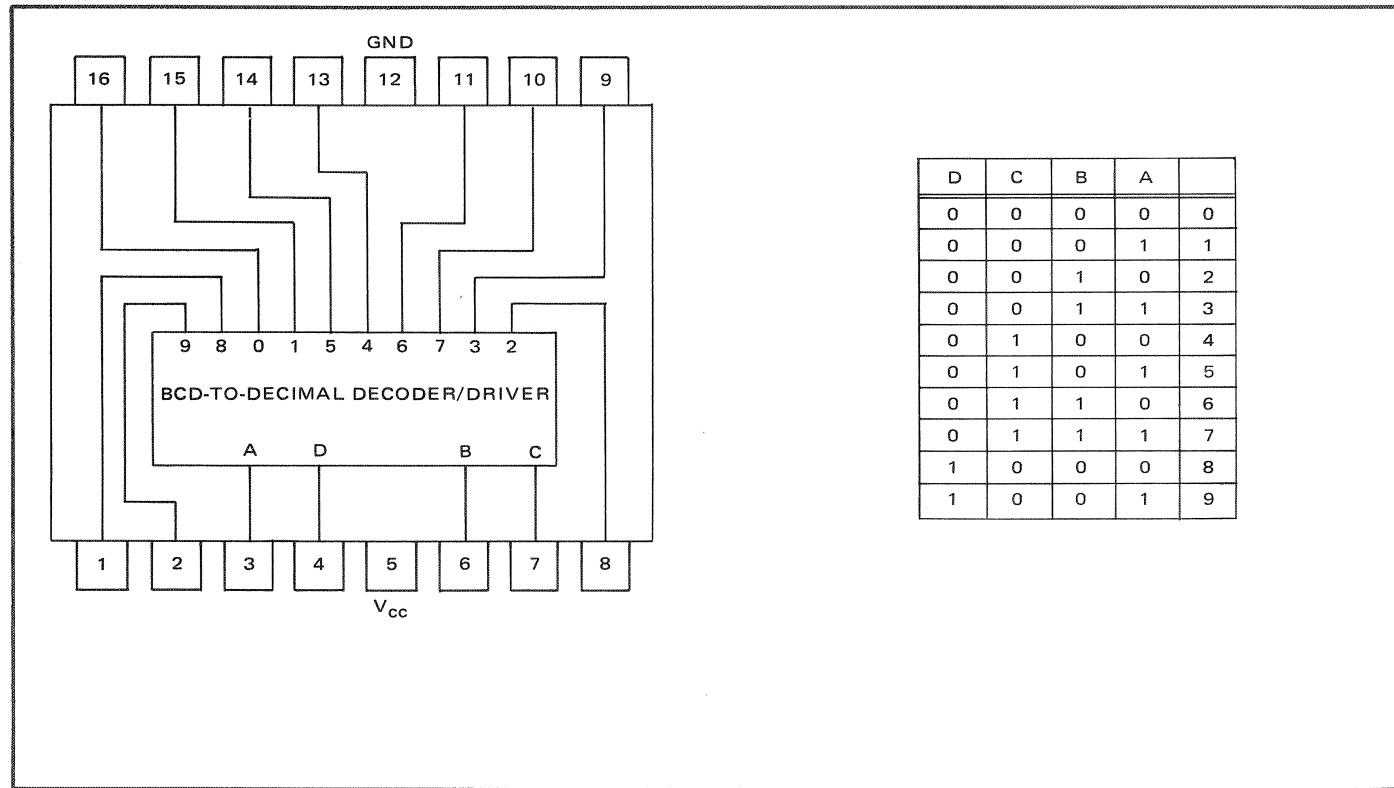
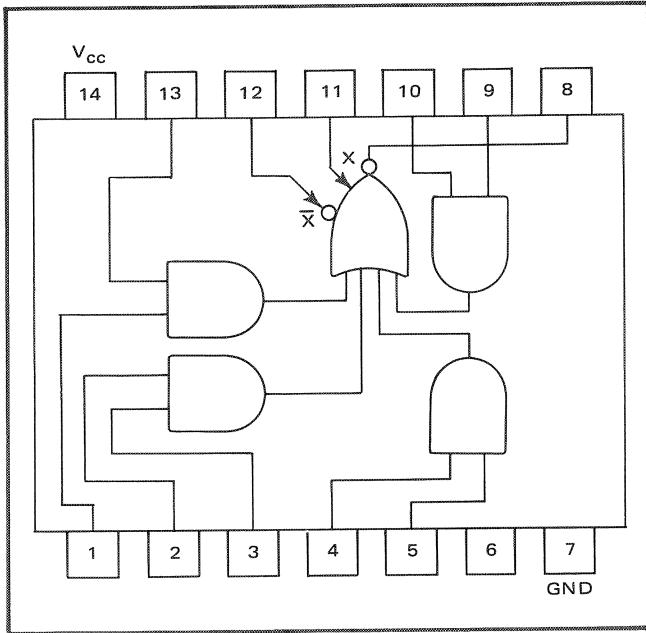


Figure 5.24 - Integrated Circuits

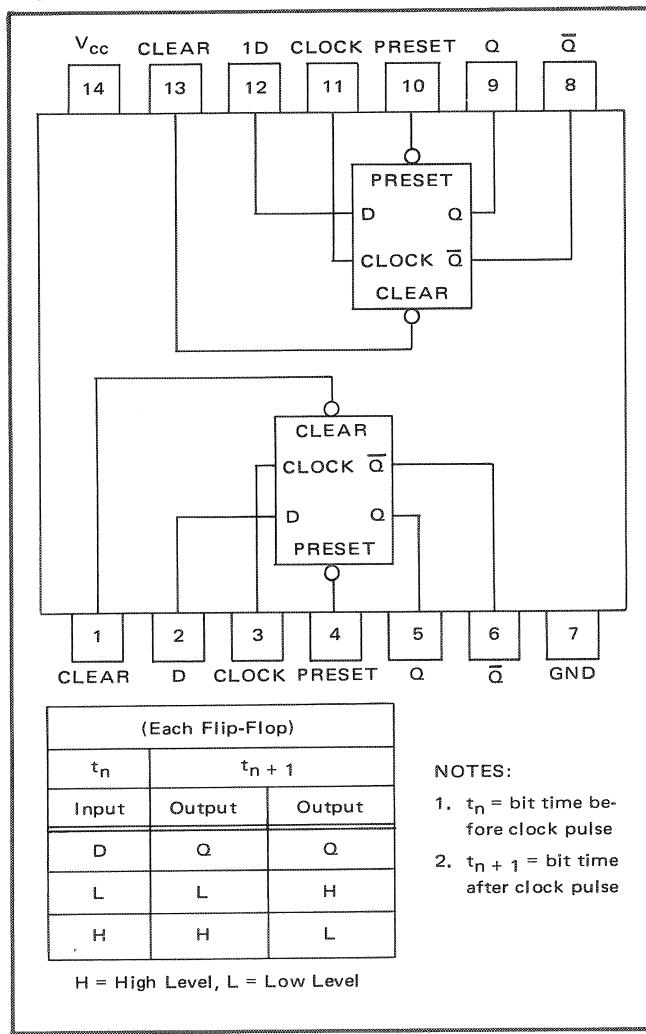
7454

4-WIDE 2-INPUT AND-OR-INVERT GATE



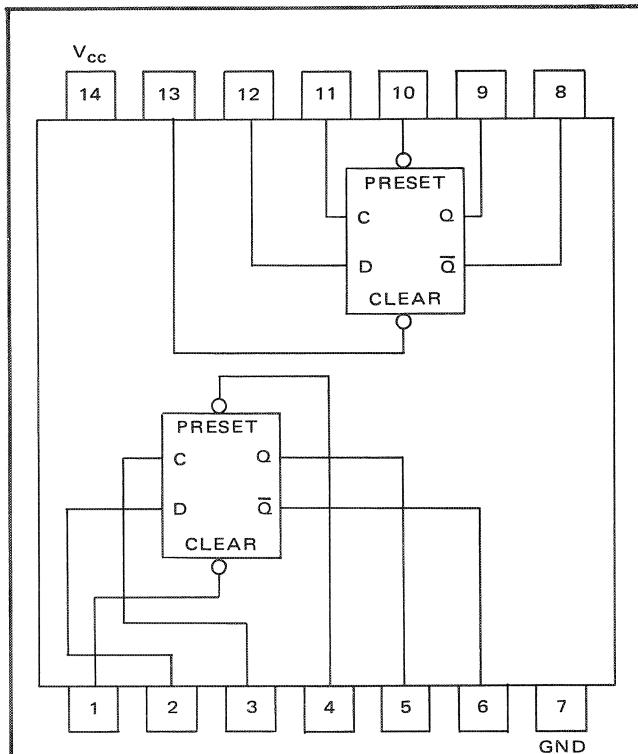
74H74

DUAL D-TYPE EDGE TRIGGERED FLIP-FLOP



7474

DUAL D-TYPE EDGE-TRIGGERED FLIP-FLOP



$D_n$	$Q_{n+1}$	$\bar{Q}_{n+1}$
1	1	0
0	0	1
Preset	Clear	Q
1	1	Q
1	0	0
0	1	1
0	0	†

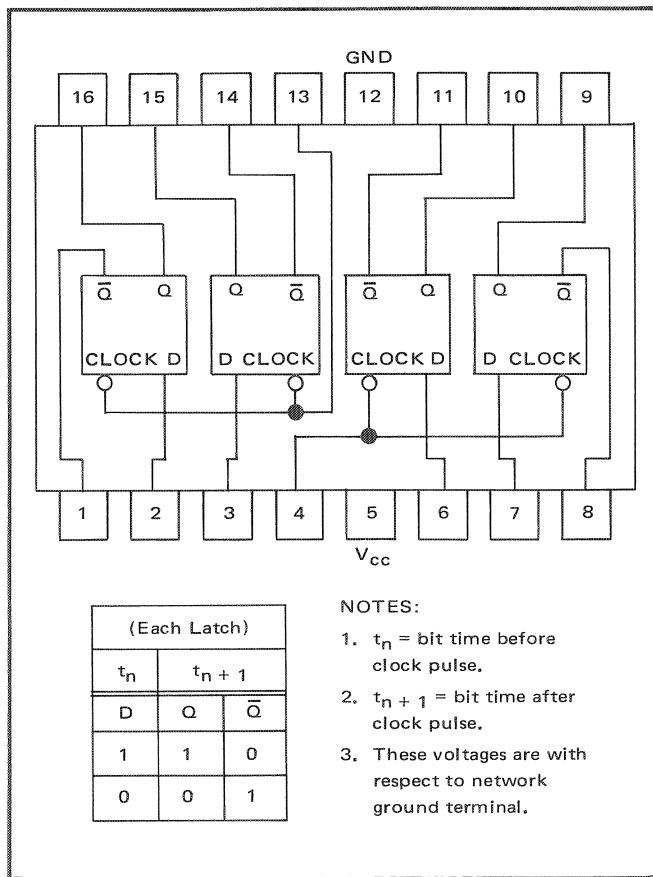
† Both outputs in 1 state

n is time prior to clock

$n + 1$  is time following clock

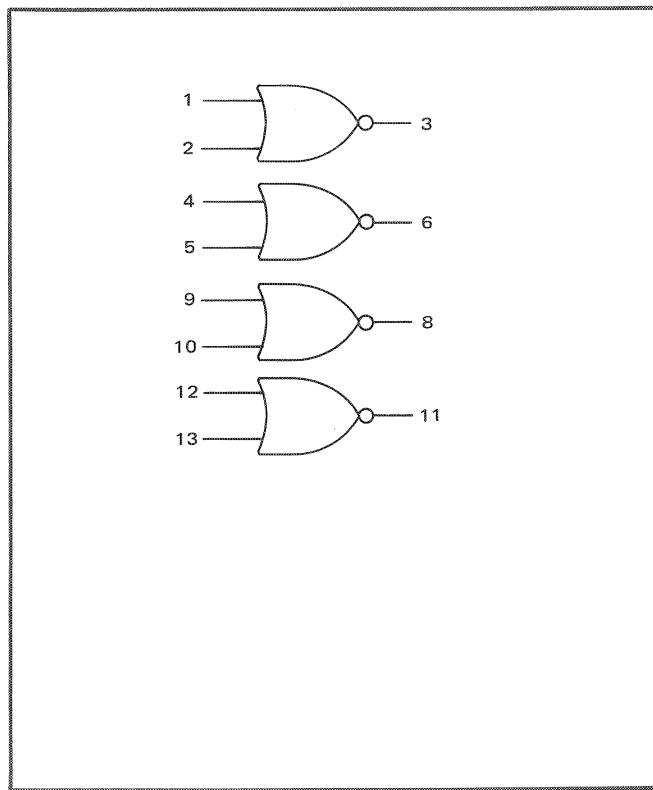
7475

## QUADRUPLE BISTABLE LATCH



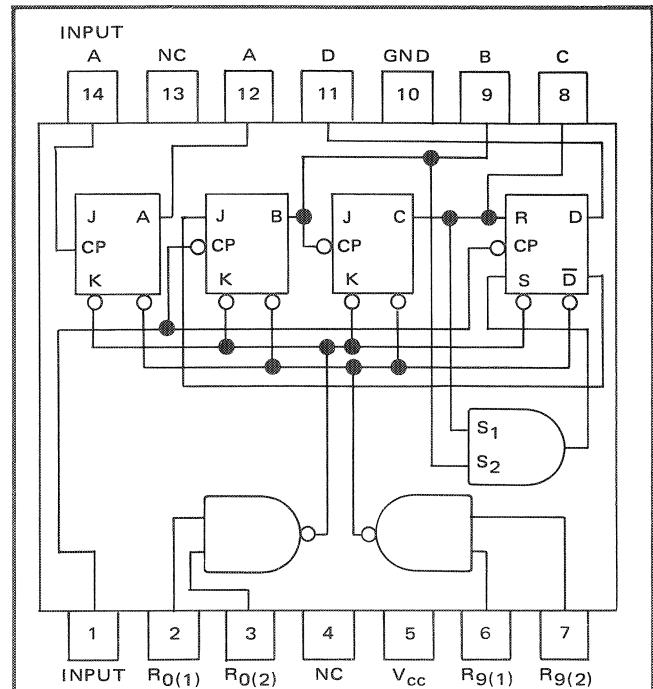
MC1010

## QUAD 2-INPUT GATES



7490

## DECADE COUNTER



BCD COUNT SEQUENCE (See Note 1)

COUNT	OUTPUT			
	D	C	B	A
0	0	0	0	0
1	0	0	0	0
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1

RESET/COUNT (See Note 2)

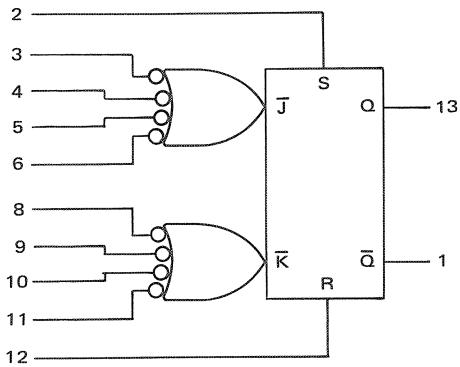
RESET INPUTS				OUTPUT			
R <sub>0(2)</sub>	R <sub>0(2)</sub>	R <sub>9(1)</sub>	R <sub>9(2)</sub>	D	C	B	A
1	1	0	X	0	0	0	0
1	1	X	0	0	0	0	0
X	X	1	1	1	0	0	1
X	0	X	0	COUNT			
0	X	0	X	COUNT			
0	X	X	0	COUNT			
X	0	0	X	COUNT			

NOTES:

1. Output A connected to input BD for BCD count.
2. X indicates that either a logical 1 or a logical 0 may be present.
3. Fanout from output A to input BD and to 10 additional Series 54/74 loads is permitted.

Figure 5.24 - Integrated Circuits continued

### MC1013/MC1027 AC-COUPLED J-K FLIP-FLOP



MC1013

DC Input Loading Factor = 1

DC Output Loading Factor = 25

tpd = 6.0 ns typ

Power Dissipation = 125 mW

typ

MC1027

DC Input Loading Factor = 2

DC Output Loading Factor = 25

tpd = 4.0 ns typ

Power Dissipation = 250 mW

typ

R-S TRUTH TABLE

Pin No.	R	S	$Q^n + 1$
12	2	13	
0	0	$Q^n$	
0	1	1	
1	0	0	
1	1	N.D.	

All  $\bar{J}$ - $\bar{K}$  inputs are static.

N.D. = Not defined.

 $\bar{J}_D$  -  $\bar{K}_D$  TRUTH TABLE

Pin No.	$\bar{J}_D$	$\bar{K}_D$	$Q^n + 1$
*	*	13	
0	0	$Q^n$	
0	1	0	
1	0	1	
1	1	$\bar{Q}^n$	

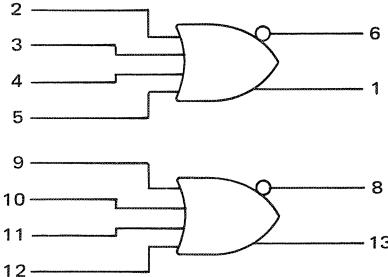
All other  $\bar{J}$ - $\bar{K}$  inputs and the R-S inputs are at a "0" level.CLOCKED  $\bar{J}$ - $\bar{K}$  TRUTH TABLE

Pin No.	$\bar{J}$	$\bar{K}$	$\bar{C}_D$	$Q^n$
*	*	**	13	
$\emptyset$	$\emptyset$	0	$Q^n$	
0	0	1	$\bar{Q}^n$	
0	1	1	1	
1	0	1	0	
1	1	1	$Q^n$	

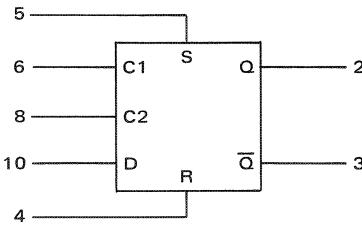
All other  $\bar{J}$ - $\bar{K}$  inputs and the R-S inputs are at a "0" level. $\emptyset$  = Either state will result in the desired output.\* Any  $\bar{J}$  or  $\bar{K}$  input, not used for  $\bar{C}_D$ .\*\*  $\bar{C}_D$  obtained by connecting one  $\bar{J}$  and one  $\bar{K}$  input together.

The  $\bar{J}$  and  $\bar{K}$  inputs refer to logic levels while the  $\bar{C}_D$  input refers to dynamic logic swings. The  $\bar{J}$  and  $\bar{K}$  inputs should be changed to a logical "1" only while the  $\bar{C}_D$  input is in a logic "1" state. ( $\bar{C}_D$  maximum "1" level =  $V_{CC} - 0.6V$ ). Clock  $\bar{C}_D$  is obtained by tying one  $\bar{J}$  and one  $\bar{K}$  input together.

### MC1023 DUAL 4-INPUT CLOCK DRIVER



### MC1034 TYPE D FLIP-FLOP



DC Input Loading Factor:

C = 1, D = 2, R and S = 6

DC Output Loading Factor = 25

Power Dissipation = 185 mW typical using external 600-ohm pull-down resistors  
240 mW typical using internal pull-down resistors

R-S TRUTH TABLE

Pin No.	R	S	$Q^n + 1$	$\bar{Q}^n + 1$
4	5	2	3	
0	0	$Q^n$	$\bar{Q}^n$	
0	1	1	0	
1	0	0	1	
1	1	N.D.	N.D.	

N.D. = Not Defined

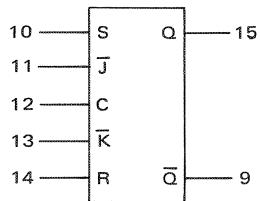
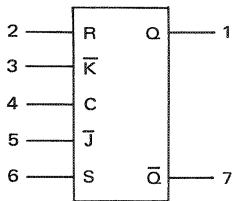
CLOCKED TRUTH TABLE

Pin No.	D	C	$Q^n + 1$	$\bar{Q}^n + 1$
10	6 or 8	2	3	
0	0	$Q^n$	$\bar{Q}^n$	
1	0	$Q^n$	$\bar{Q}^n$	
0	1*	0	1	
1	1*	1	0	

\*A "1" or Clock input is defined for this flip-flop as a change in level from a low state to a high state of the clock.

## MC1032

### 100-MHz AC-COUPLED DUAL J-K FLIP-FLOP



$V_{CC} = \text{Pin } 16$

$V_{EE} = \text{Pin } 8$

#### DC Input Loading Factor:

Clock = 2

$\bar{J}, \bar{K}, S, R = 1$

DC Output Loading Factor = 25

$t_{pd} = 4.5 \text{ ns typ}$

Power Dissipation = 180 mW typ

#### R-S TRUTH TABLE

R	S	$Q^n + 1$
2 & 14	6 & 10	1 & 15
0	0	$Q^n$
0	1	1
1	0	0
1	1	N.D.

All  $\bar{J}-\bar{K}$  inputs and Clock inputs are static  
N.D. = Not defined

#### $\bar{J}_D-\bar{K}_D$ TRUTH TABLE

$\bar{J}$	$\bar{K}$	$Q^n + 1$
*	*	1 & 15
0	0	$Q^n$
0	1	0
1	0	1
1	1	$\bar{Q}^n$

All Clock inputs and the R-S inputs are at a "0" level.

#### CLOCKED $\bar{J}-\bar{K}$ TRUTH TABLE

$\bar{J}$	$\bar{K}$	Clock	$Q^n$
*	*	4 & 12	1 & 15
$\emptyset$	$\emptyset$	0	$Q^n$
0	0	1	$\bar{Q}^n$
0	1	1	1
1	0	1	0
1	1	1	$Q^n$

All other  $\bar{J}-\bar{K}$  inputs and the R-S inputs are at a "0" level.

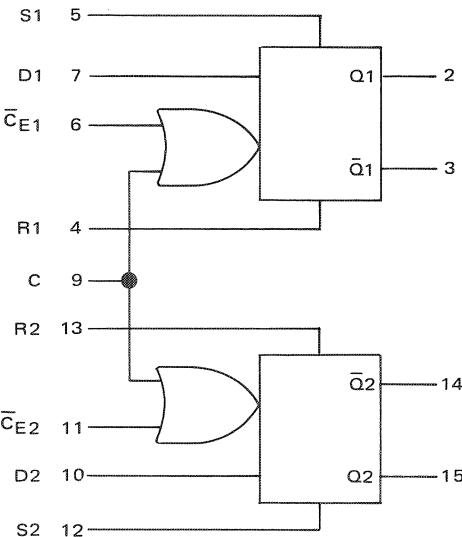
$\emptyset$  = Either state will result in the desired output,

\* Any  $\bar{J}$  or  $\bar{K}$  input

The  $\bar{J}$  and  $\bar{K}$  inputs refer to logic levels while the clock input refers to dynamic logic swings. The  $\bar{J}$  and  $\bar{K}$  inputs should be changed to a logic "1" only while the clock input is in a logic "1" state. (Clock maximum "1" level =  $V_{CC} - 0.7V$ .)

## MC10131

### DUAL TYPE D MASTER-SLAVE FLIP-FLOP



$V_{CC1} = \text{Pin } 1$

$V_{CC2} = \text{Pin } 16$

$V_{EE} = \text{Pin } 8$

#### R-S TRUTH TABLE

R	S	$Q^n + 1$	$\bar{Q}^n + 1$
L	L	$Q^n$	$\bar{Q}^n$
L	H	H	L
H	L	L	H
H	H	N.D.	N.D.

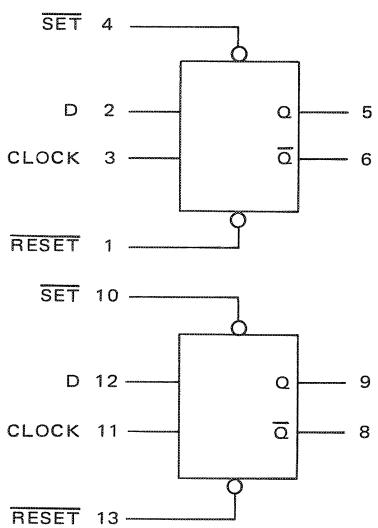
N.D. = Not Defined

#### SEQUENTIAL TRUTH TABLE

D	C	$\bar{C}_E$	$Q_{n+1}$
L	L	L	$Q_n$
L	L	H	L
L	H	L	$Q_n$
L	H	H	$Q_n$
H	L	L	$Q_n$
H	L	H	H
H	H	L	$Q_n$
H	H	H	$Q_n$

## DUAL TYPE D FLIP-FLOP

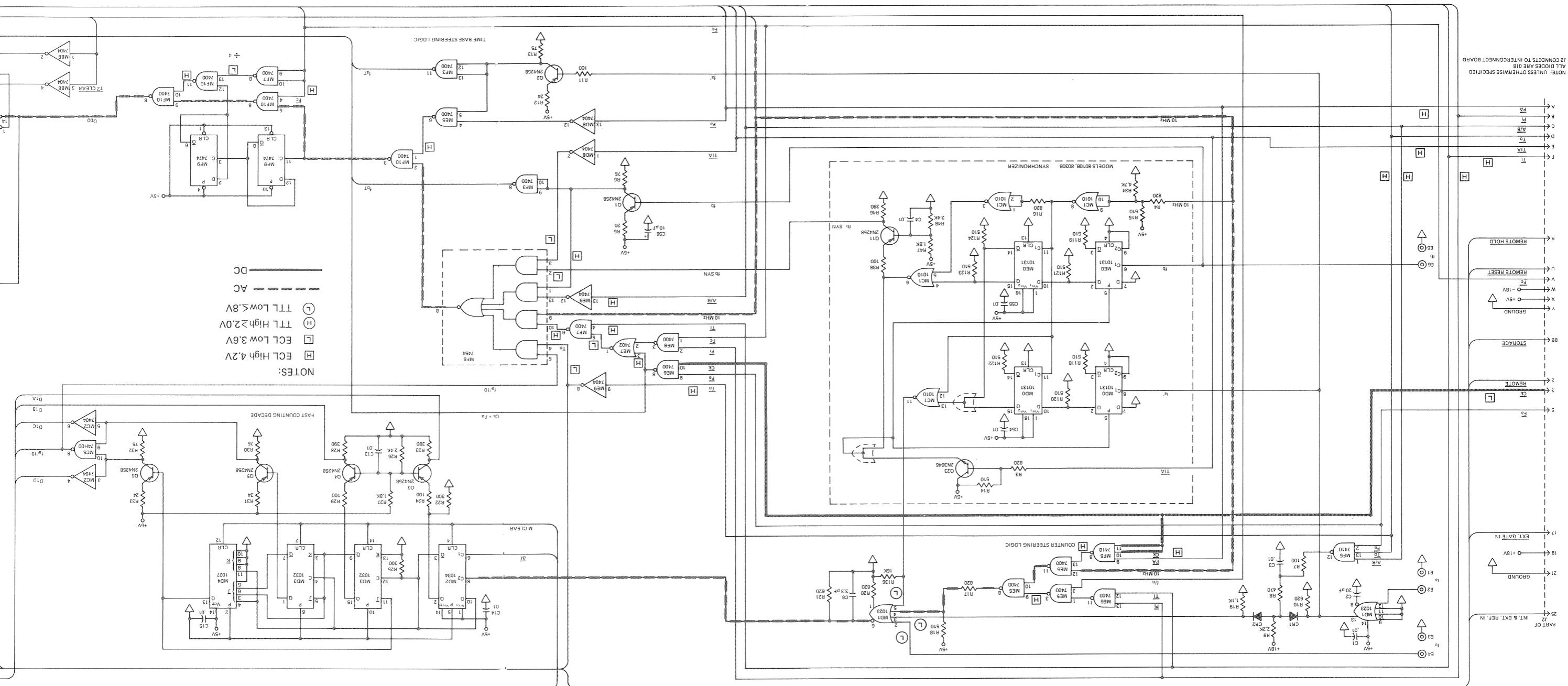
MC3060F

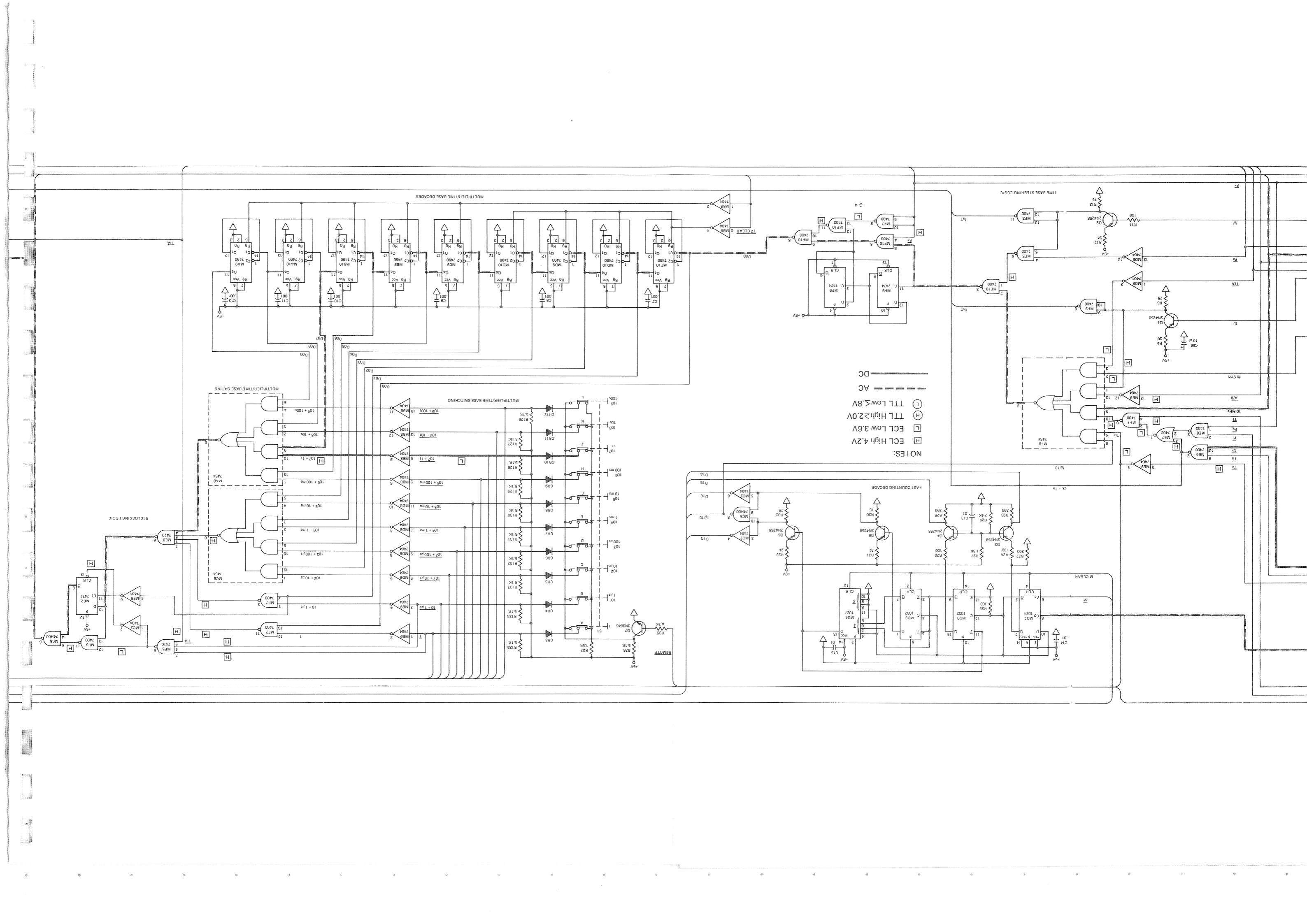


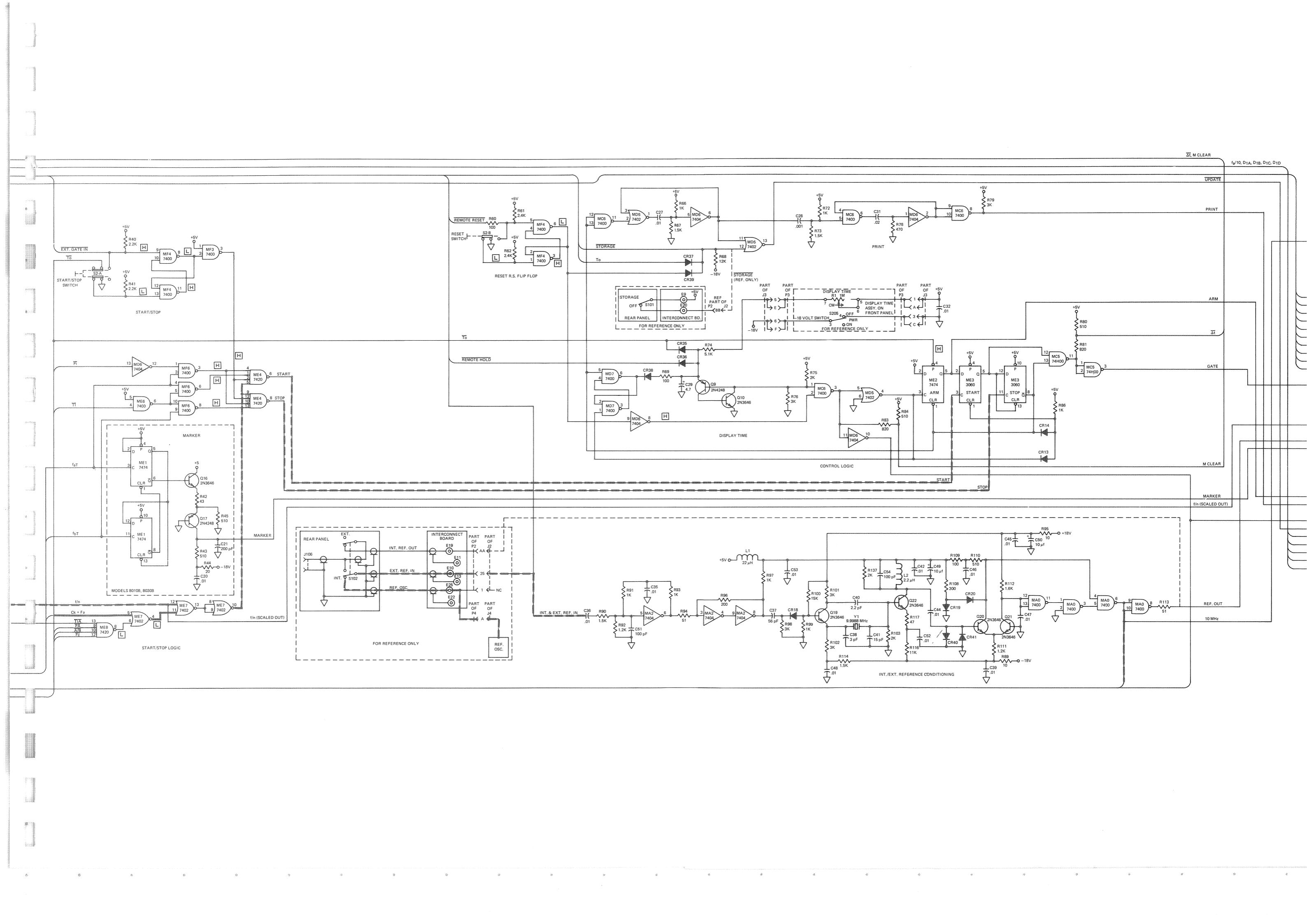
TRUTH TABLE

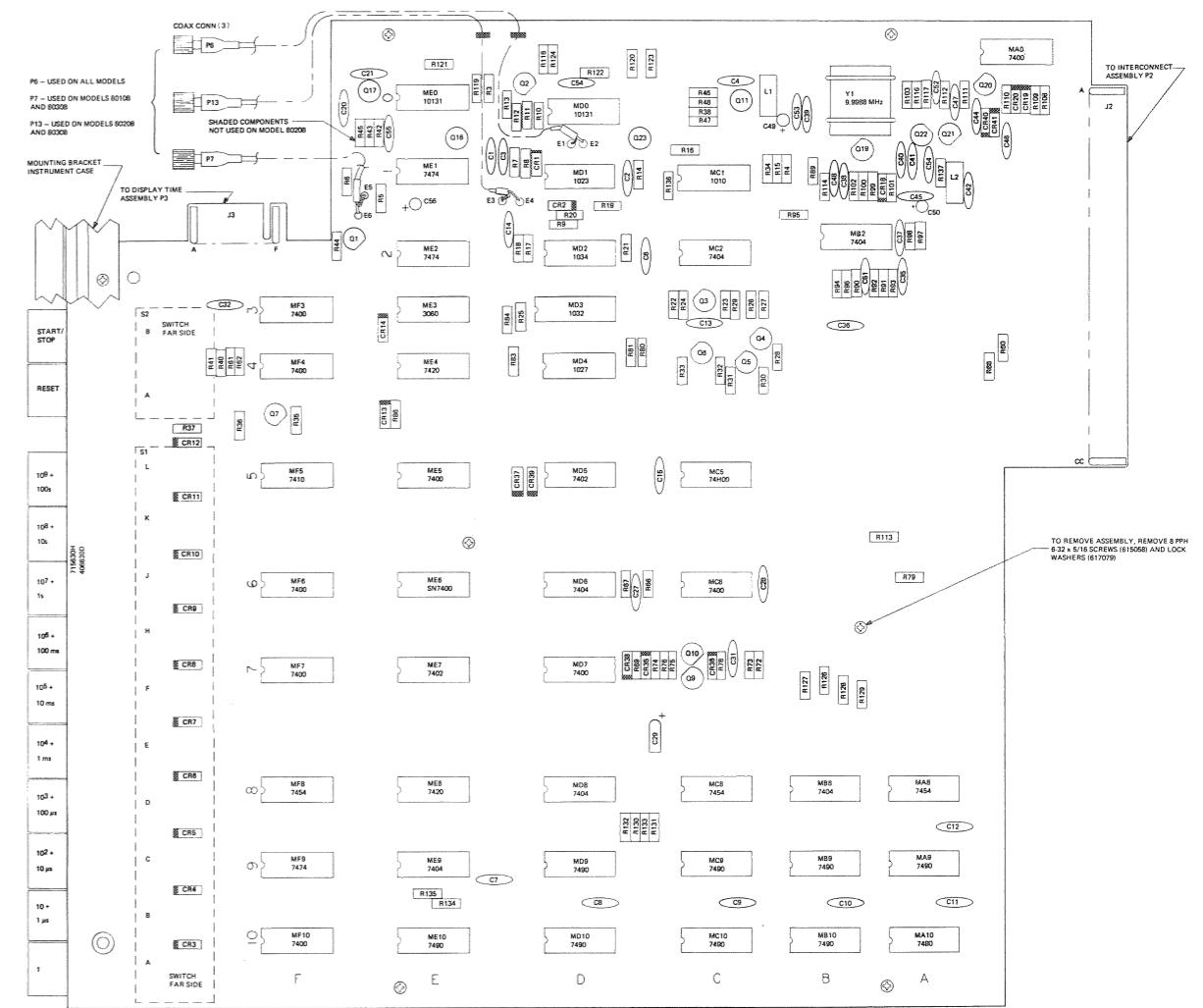
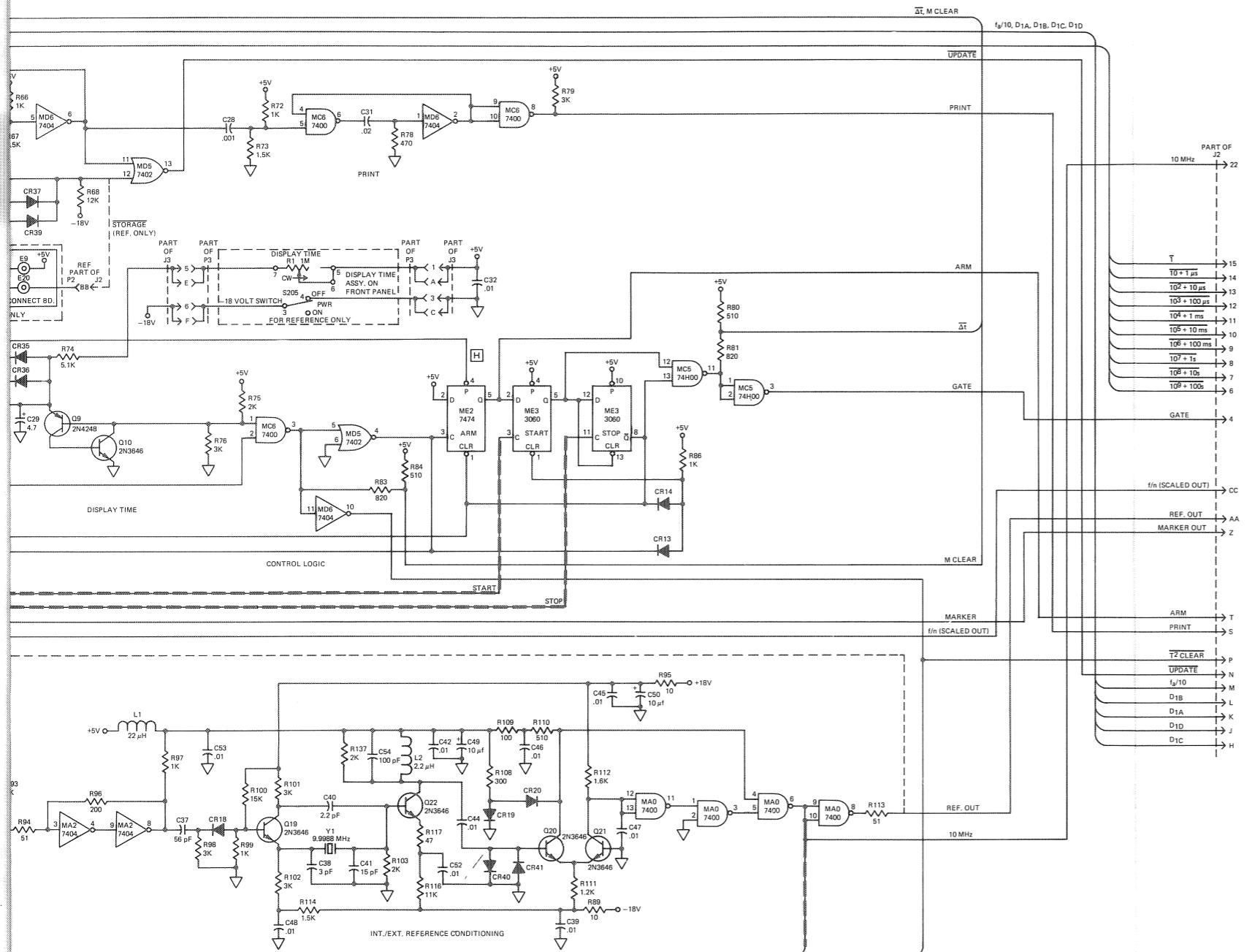
D	$Q^n$	$Q^{n+1}$
0	0	0
0	1	0
1	0	1
1	1	1

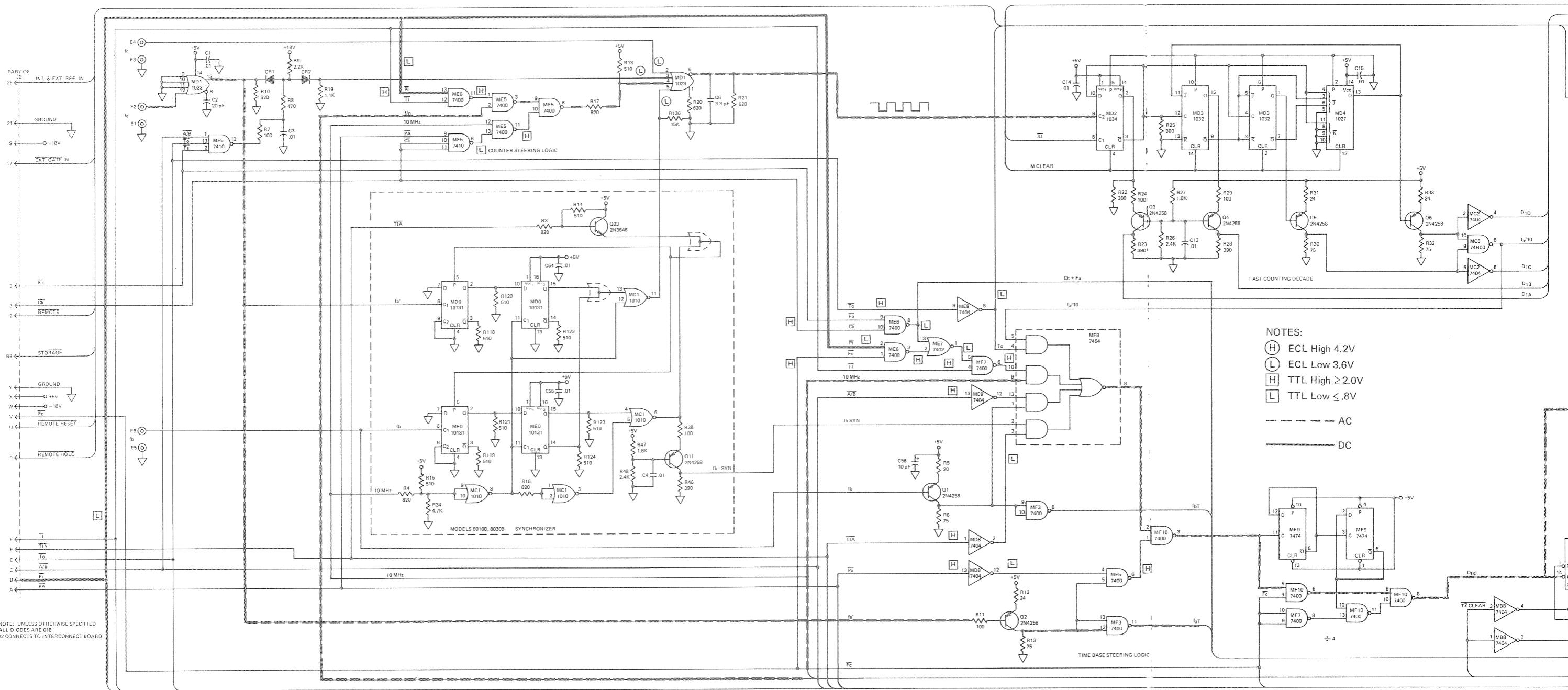
$$Q^{n+1} = D^n$$

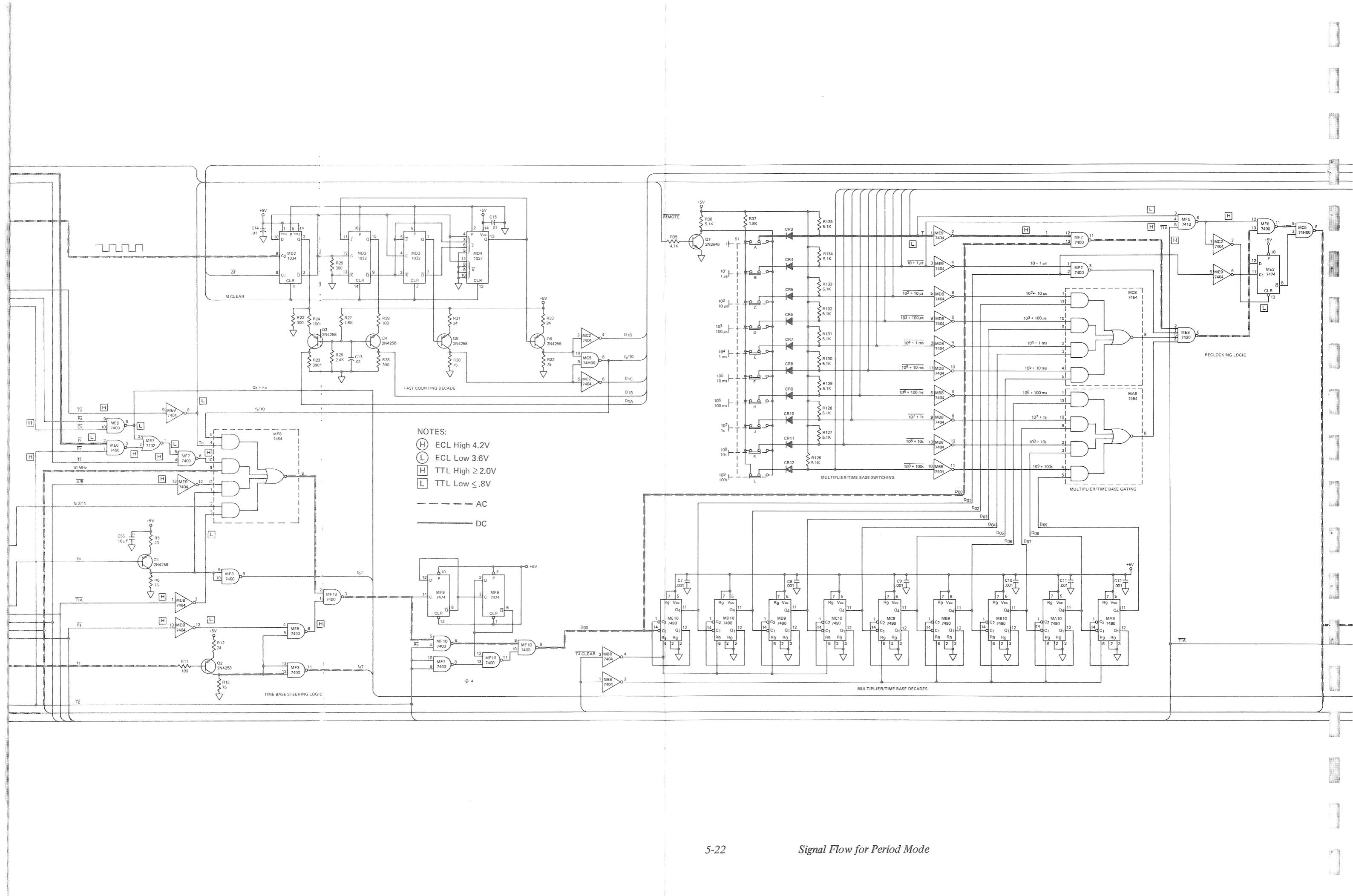


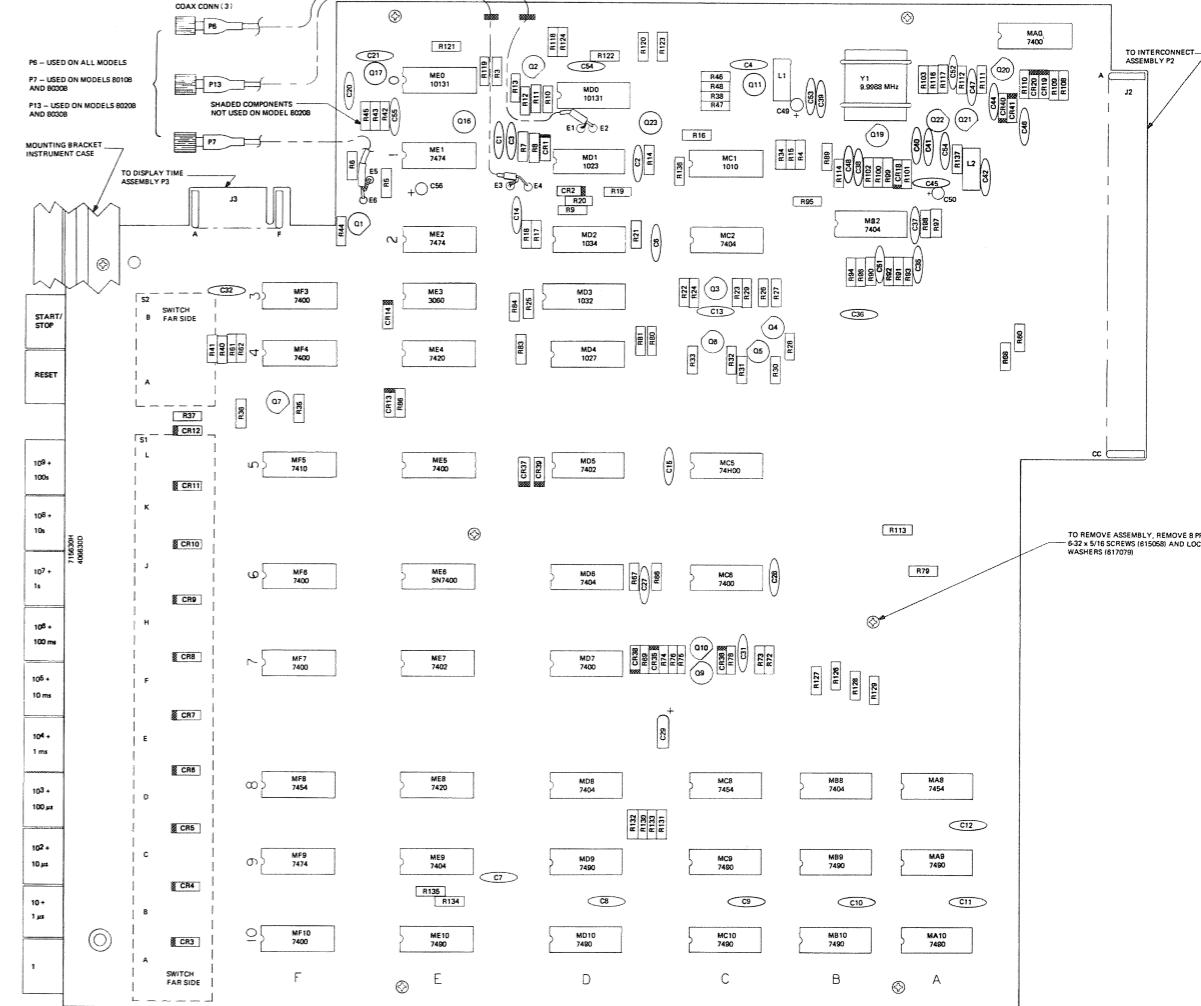
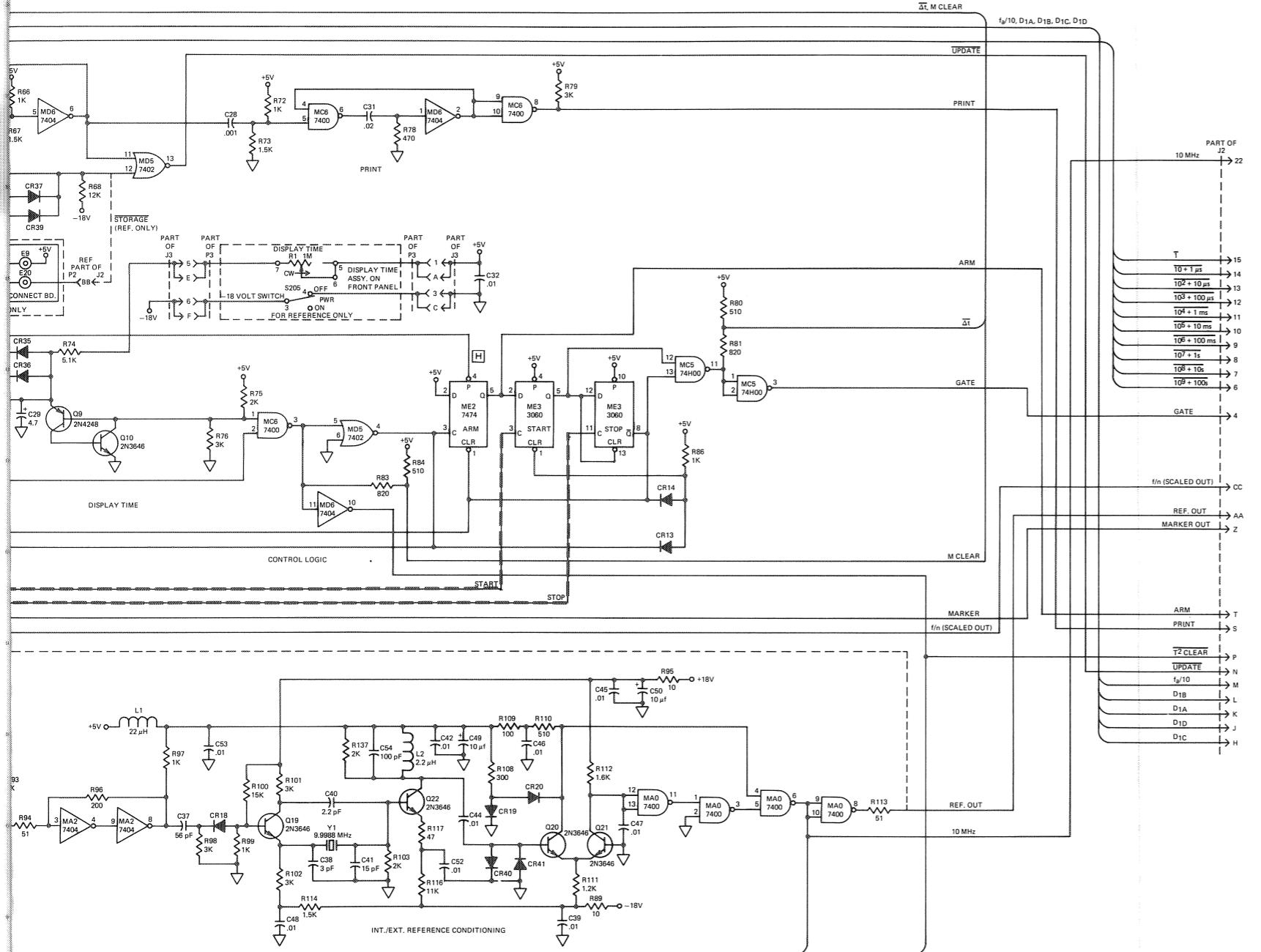


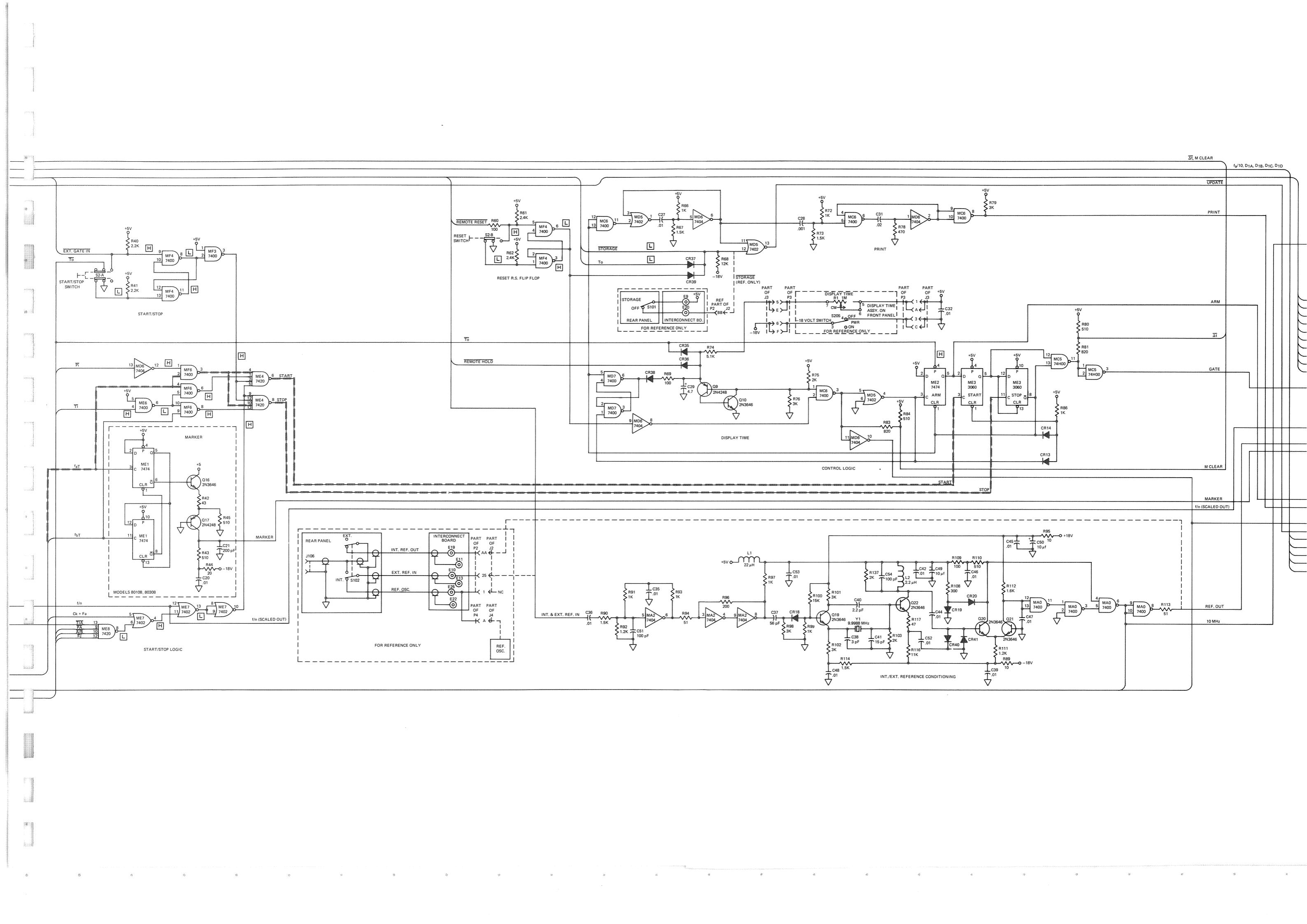


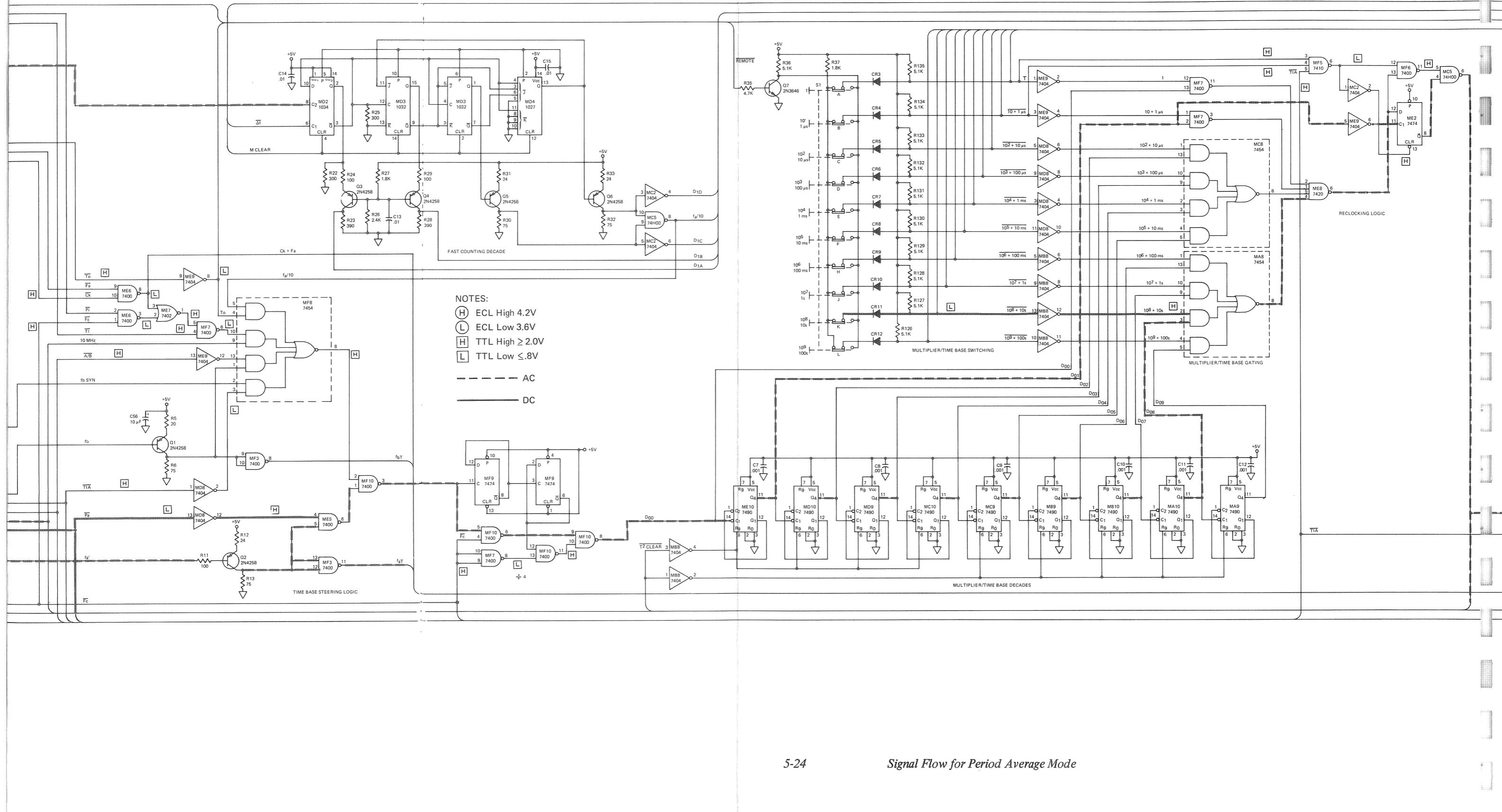


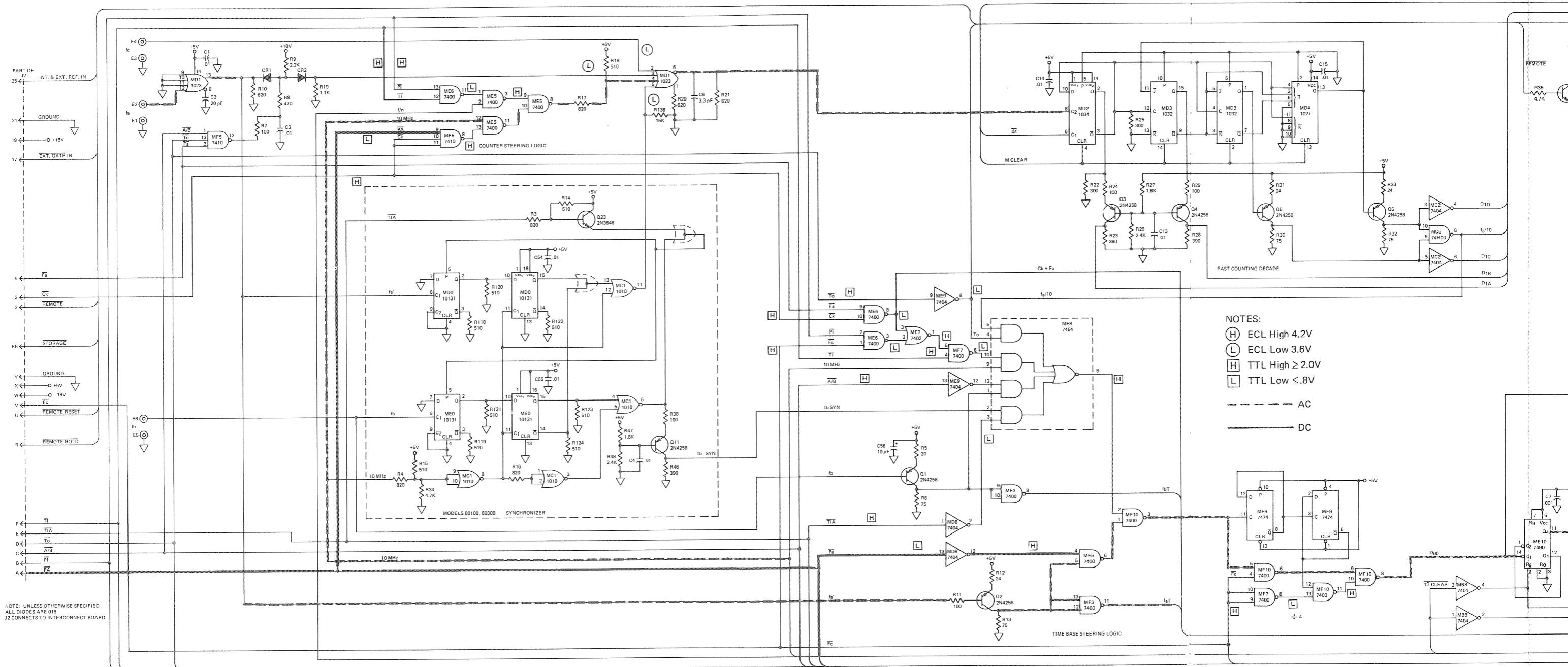


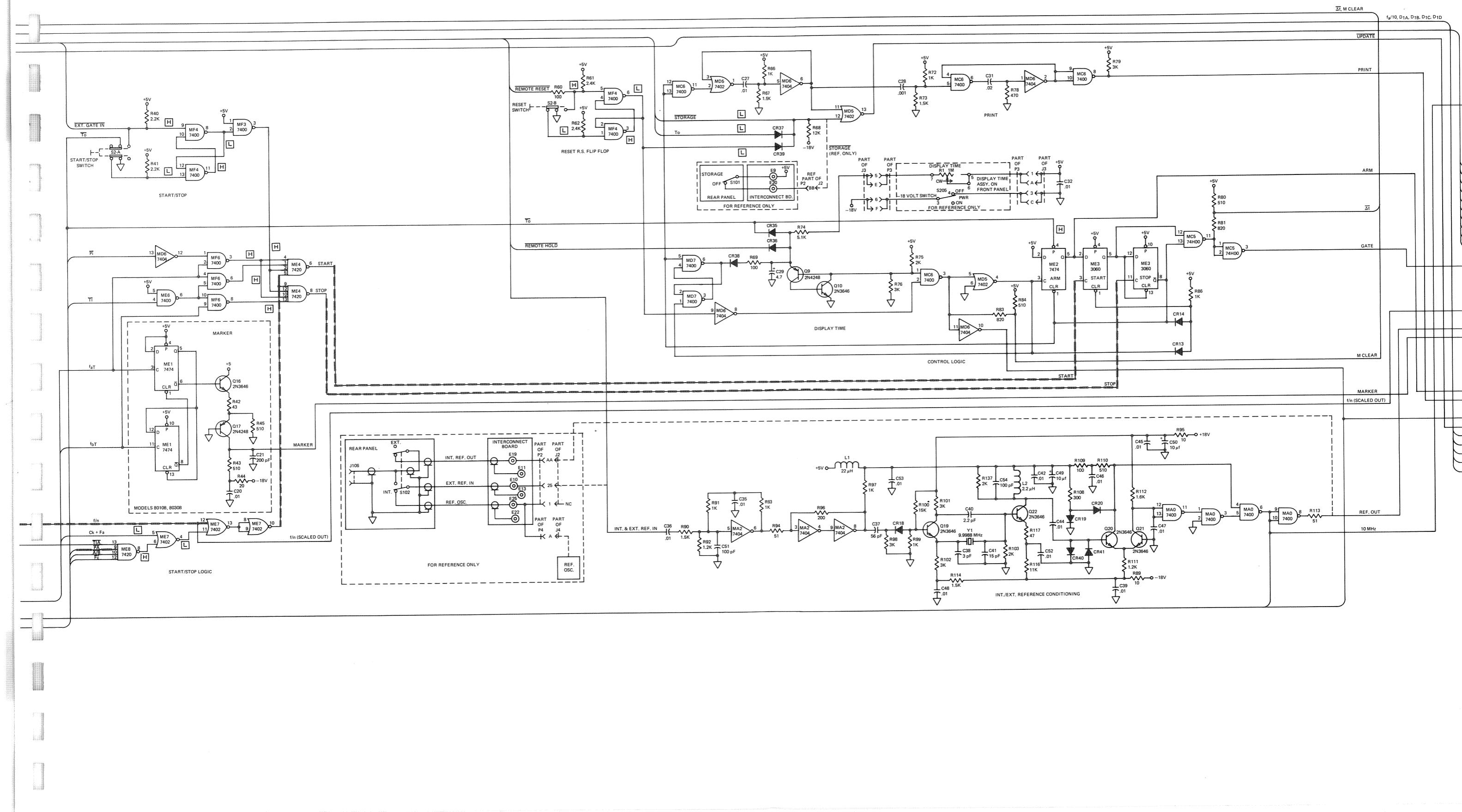


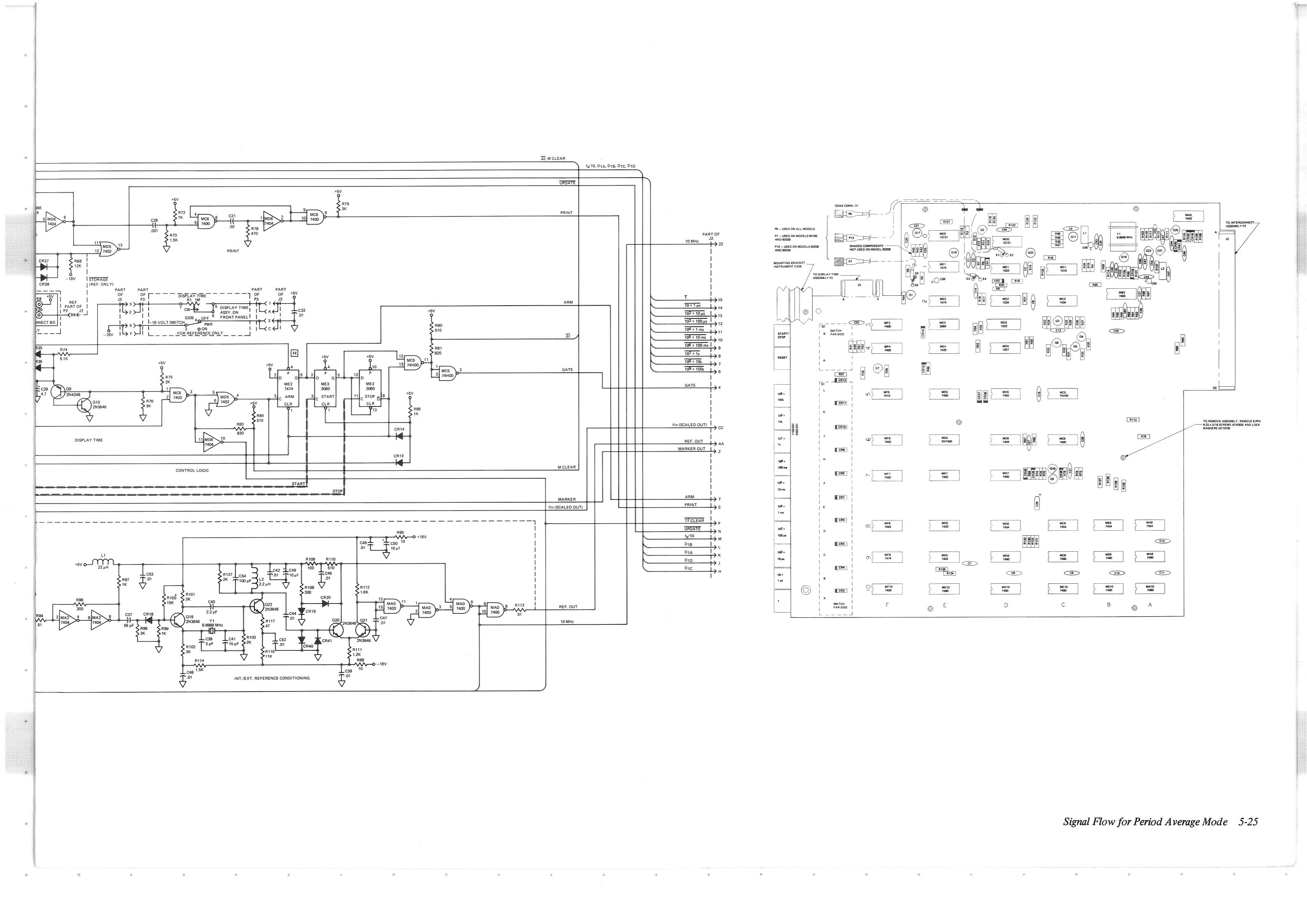


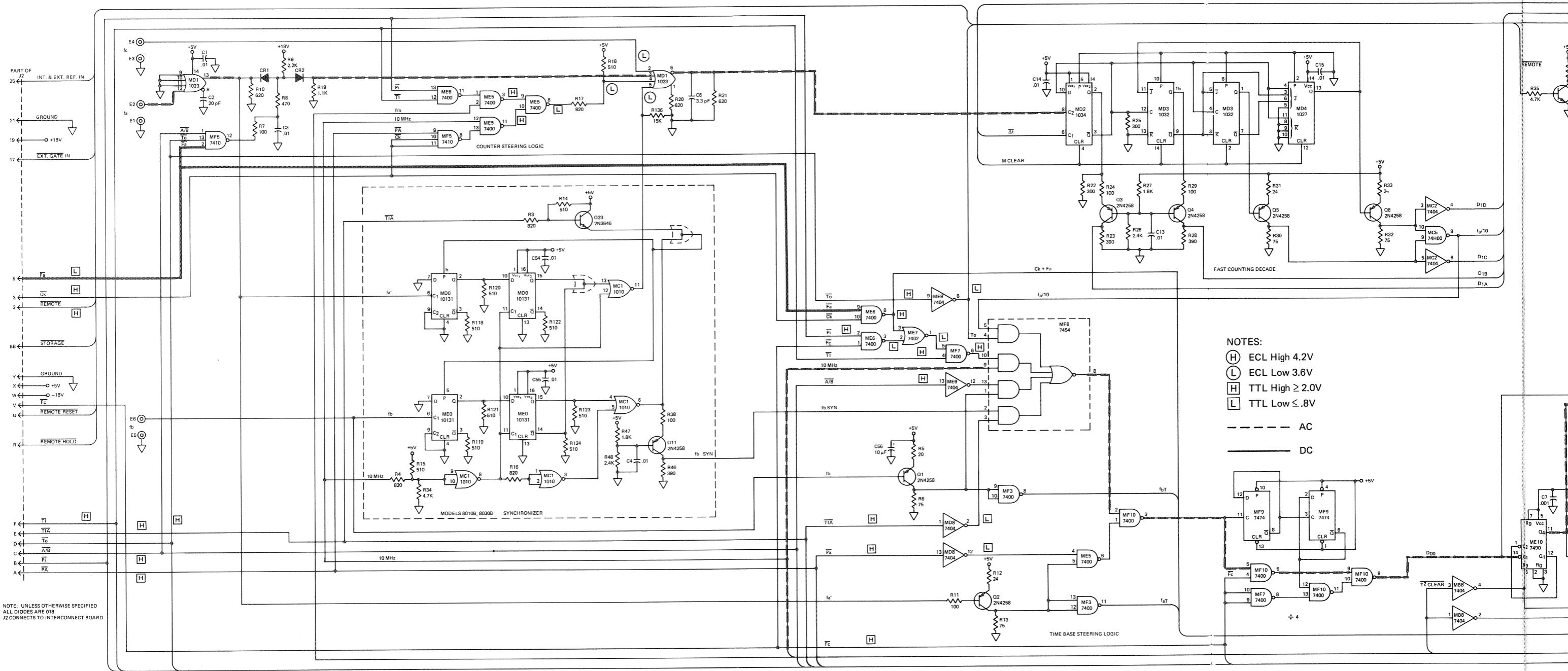


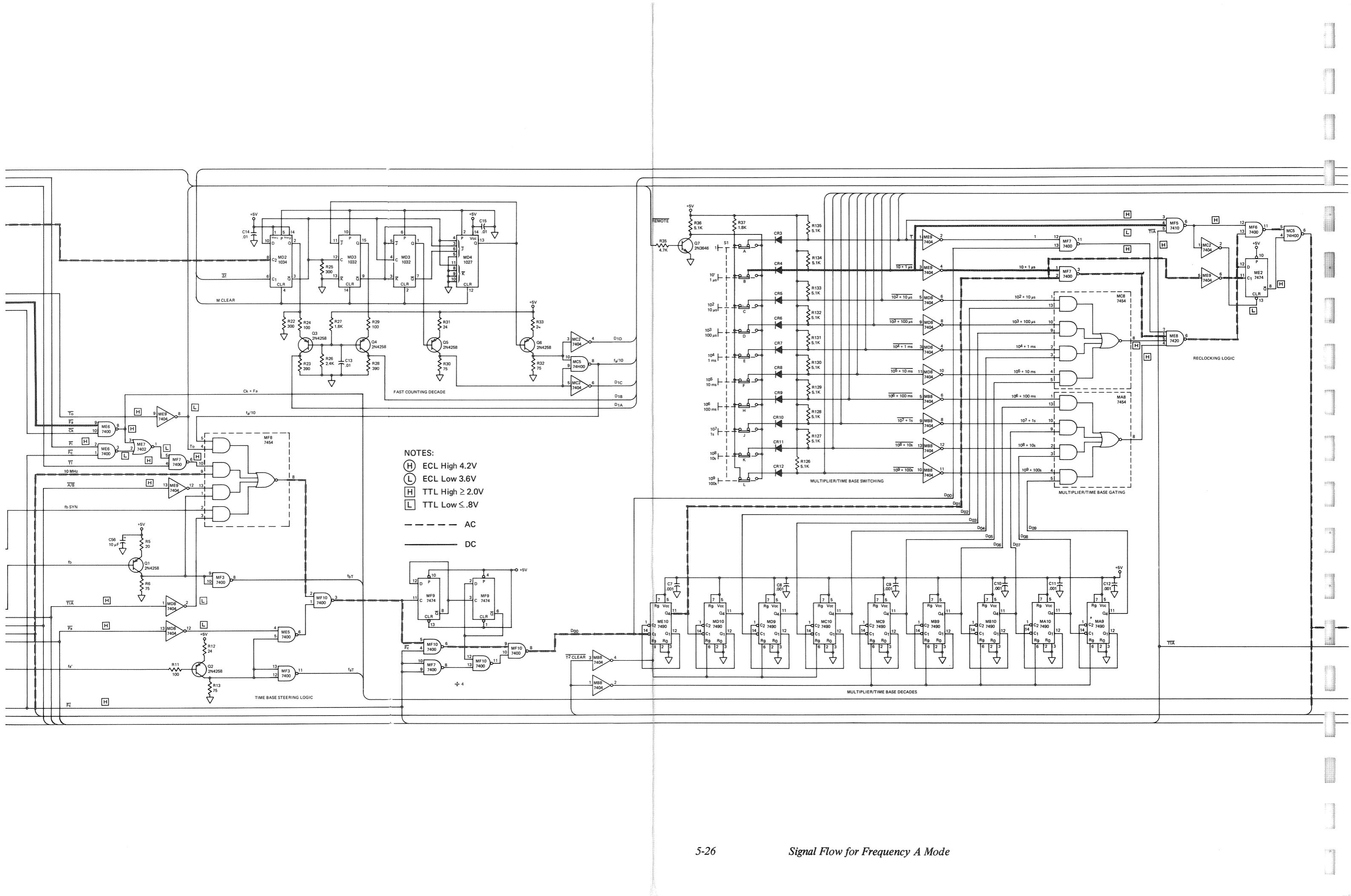


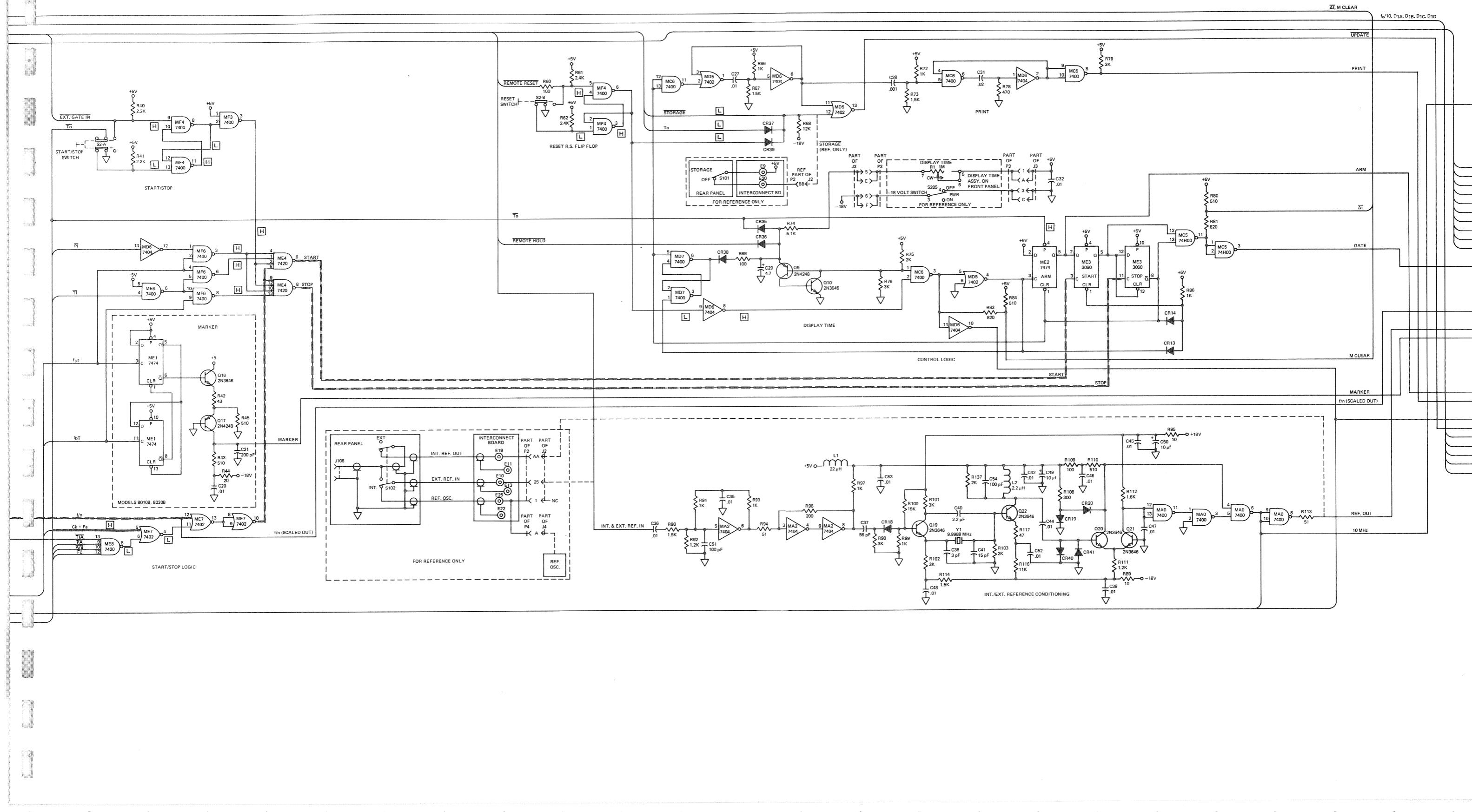


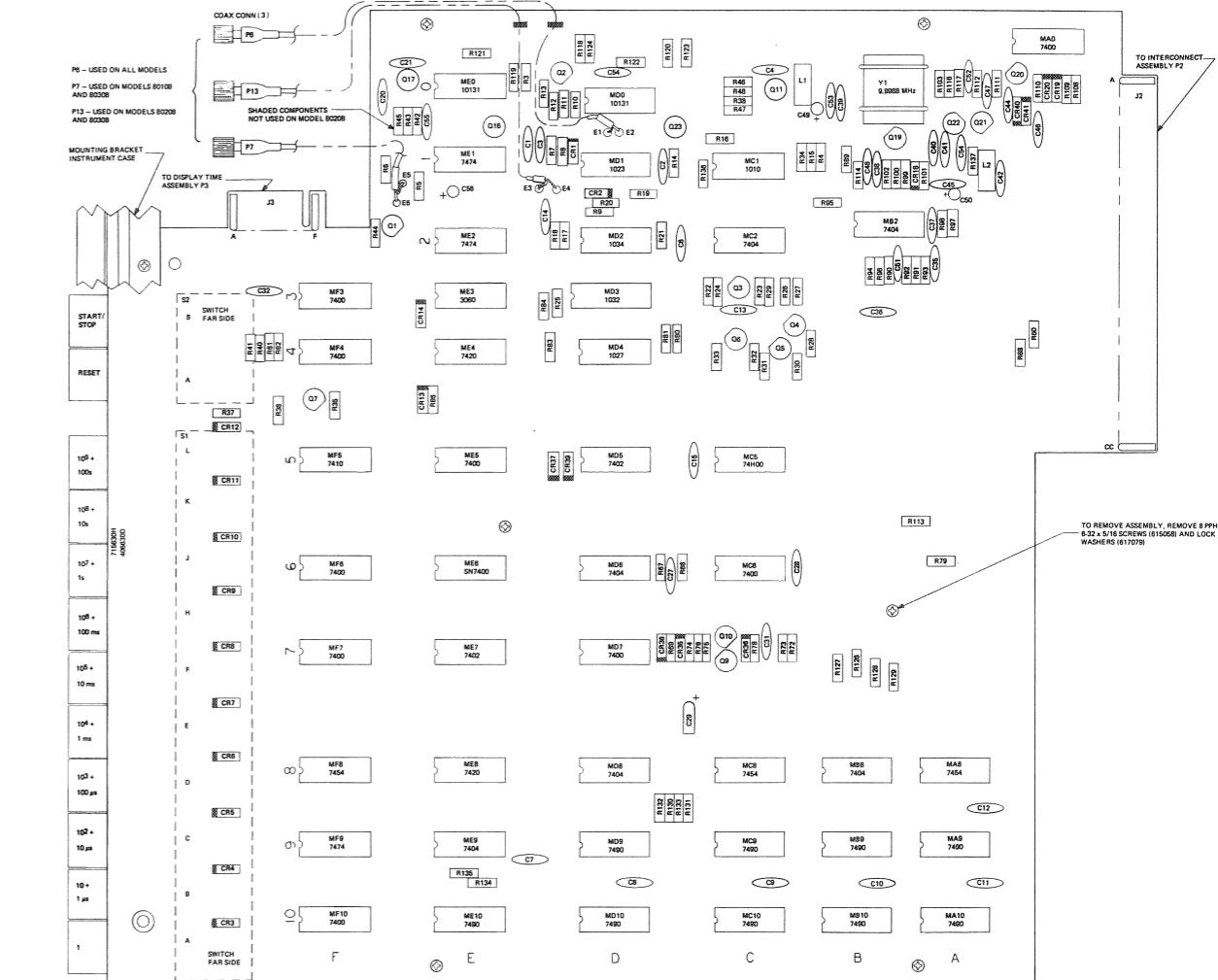
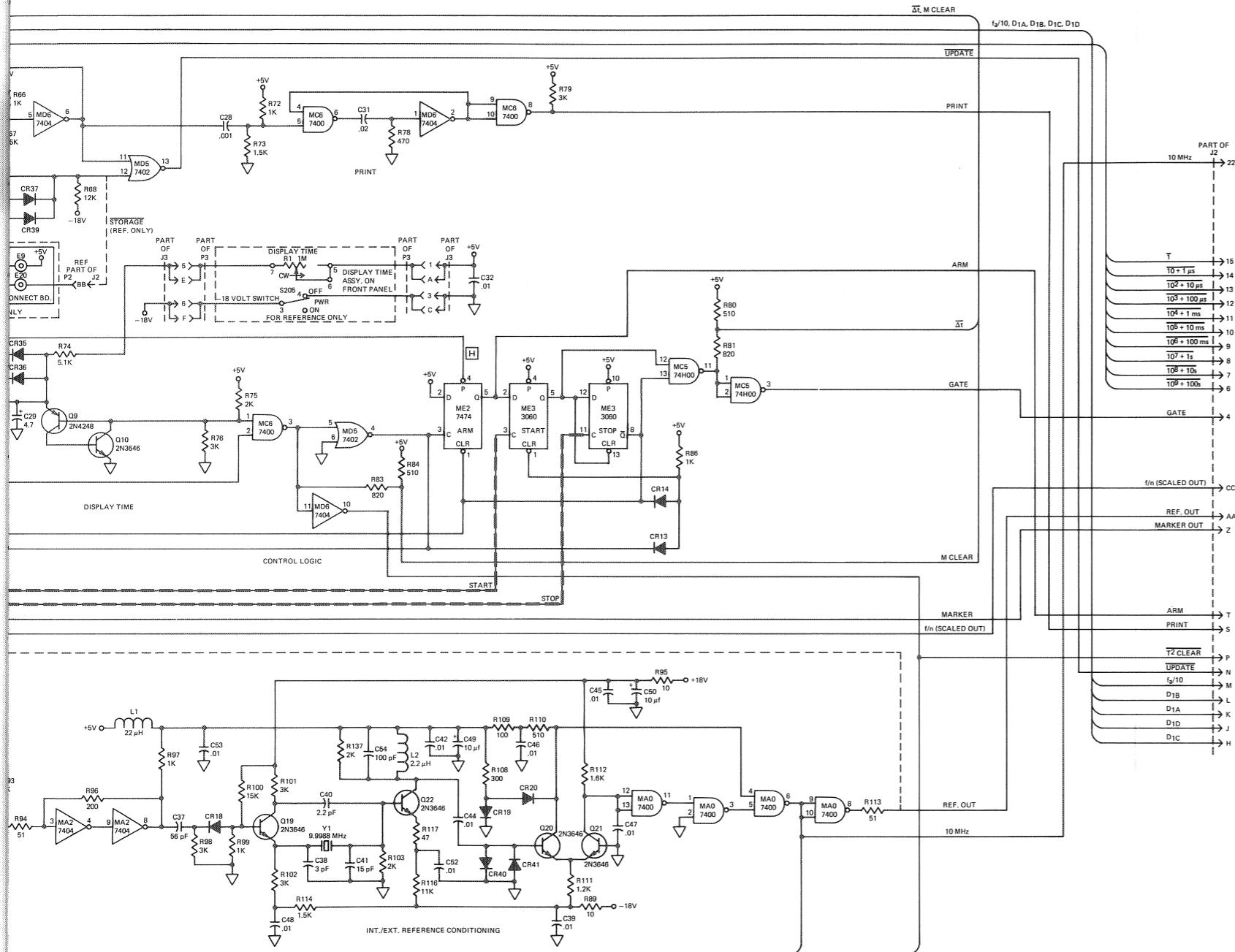


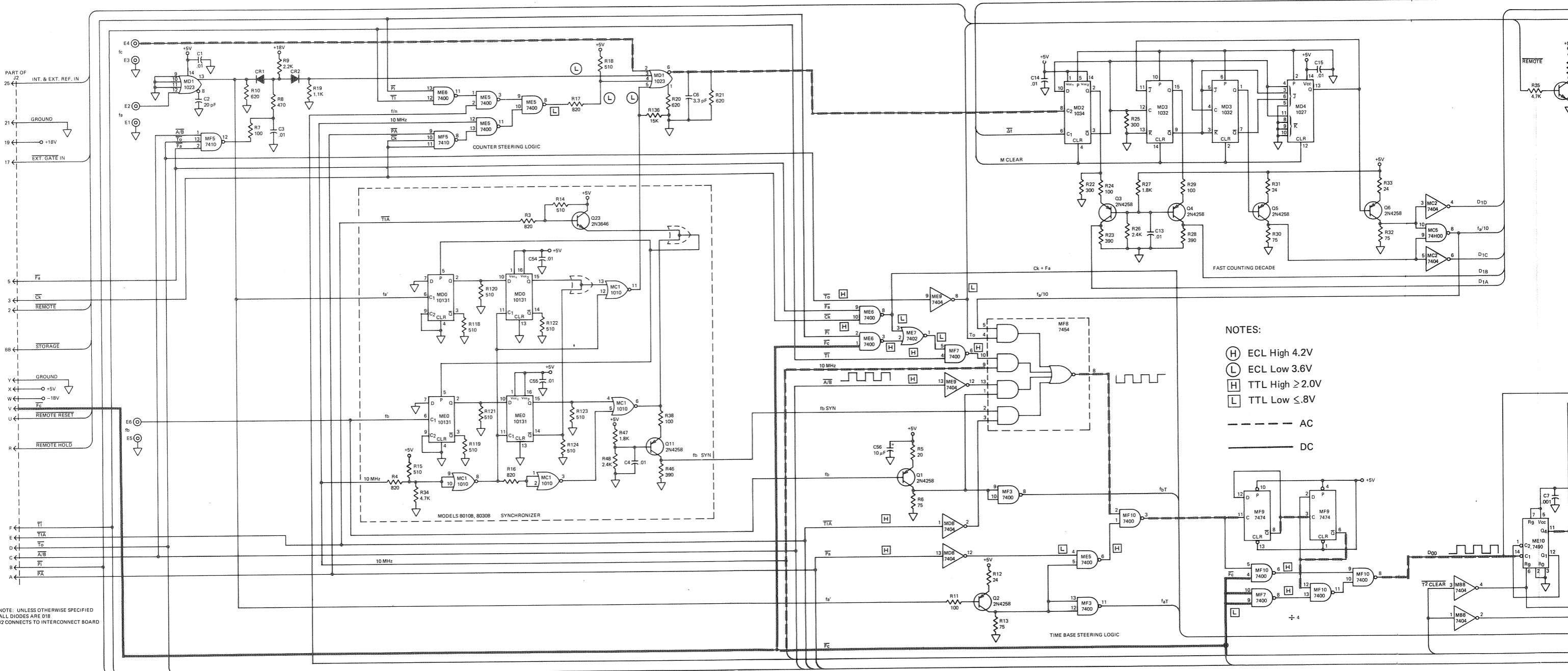


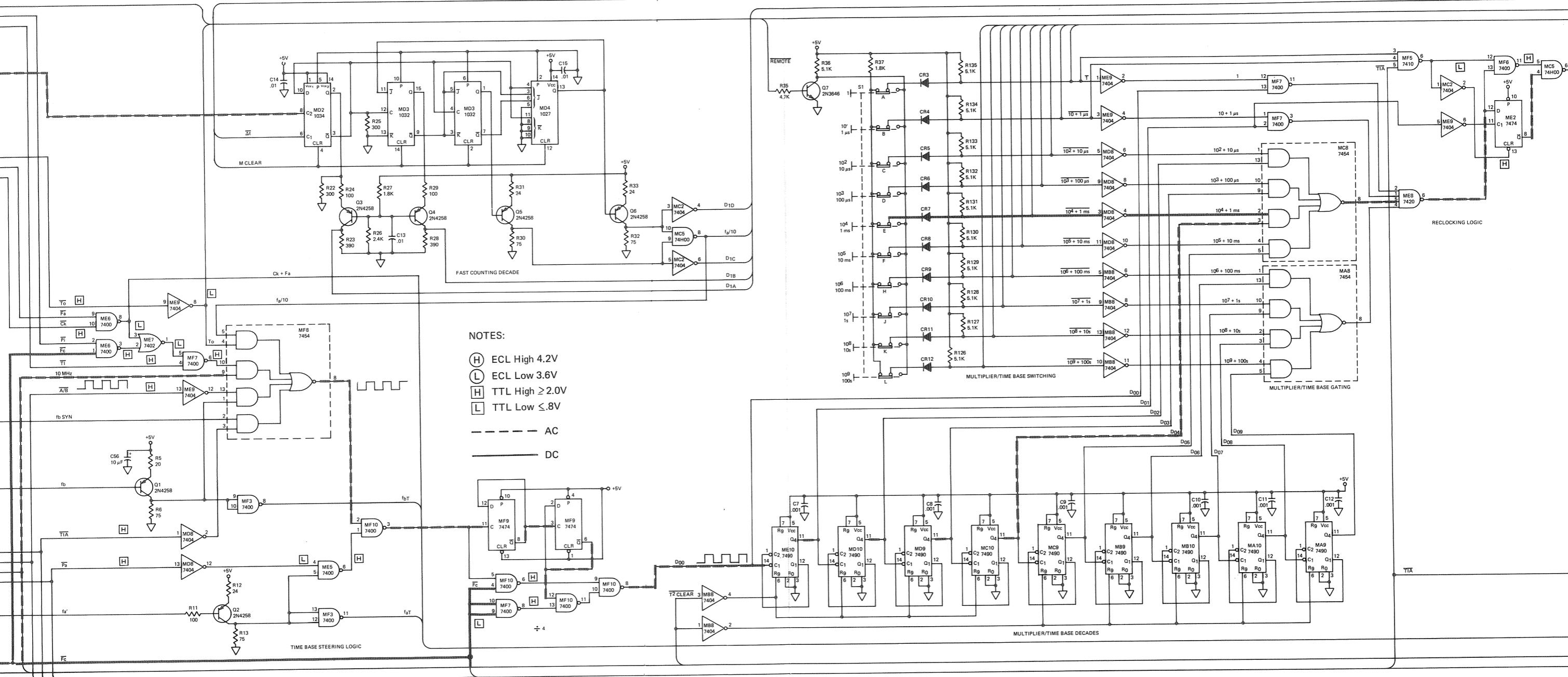


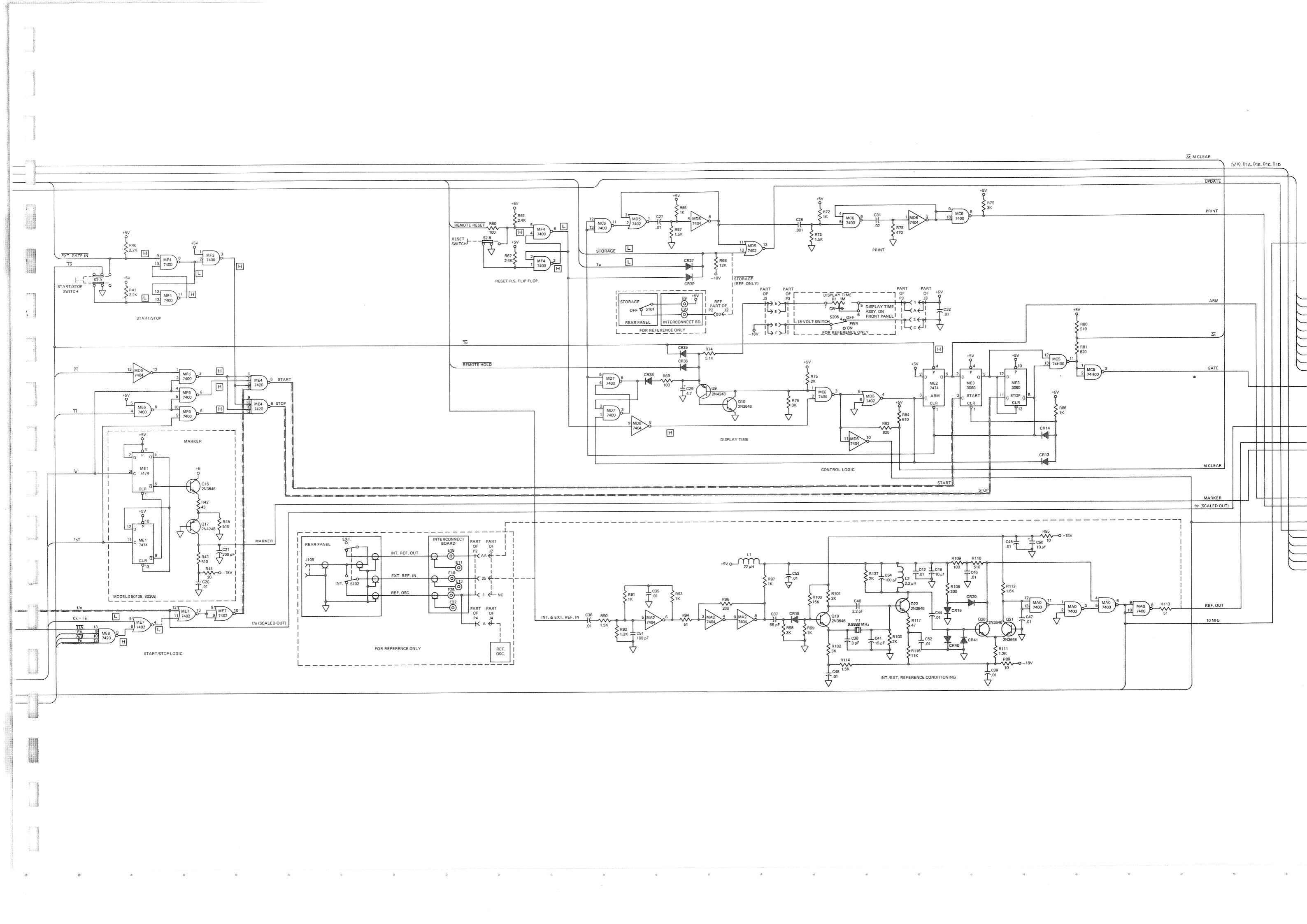


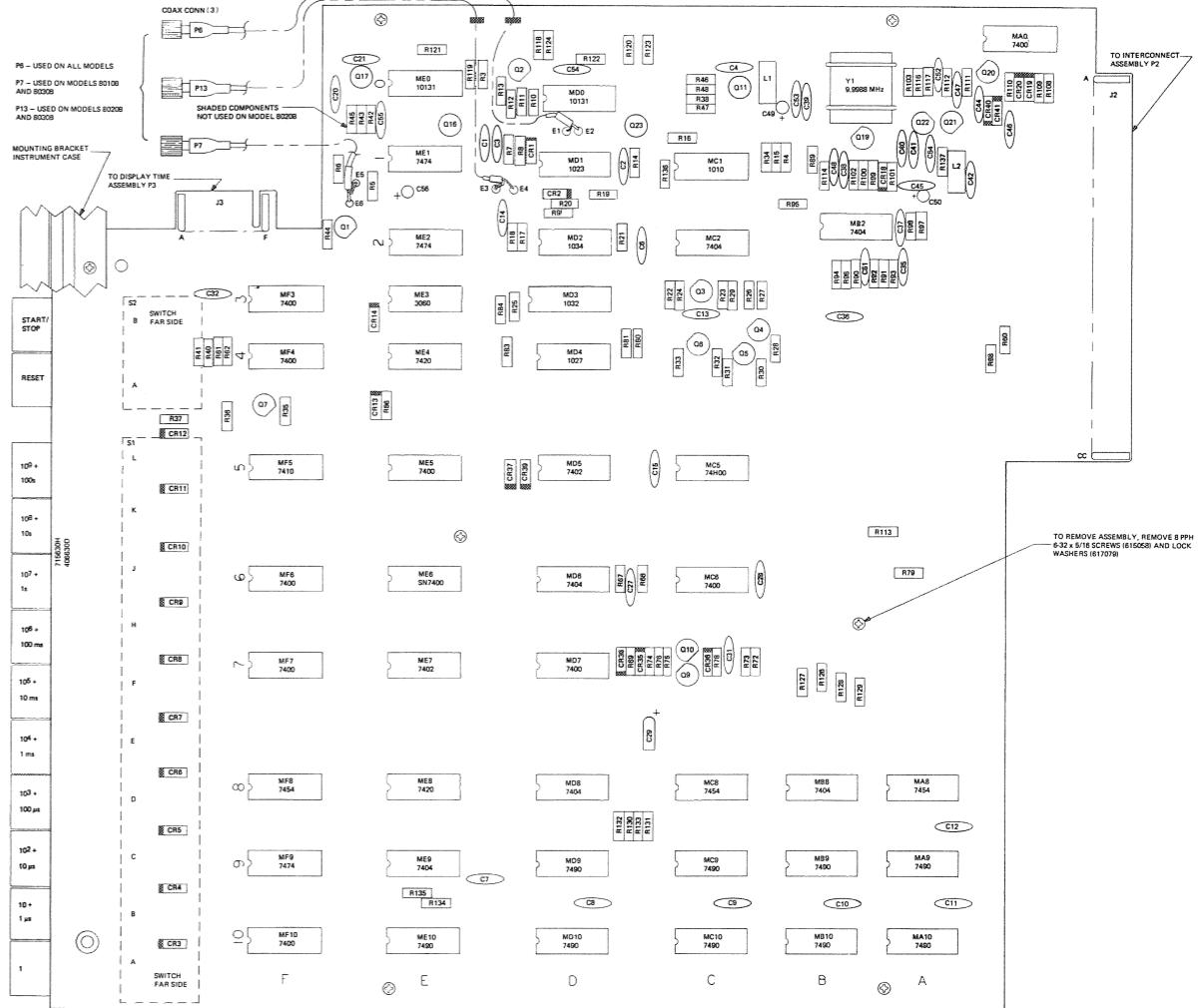
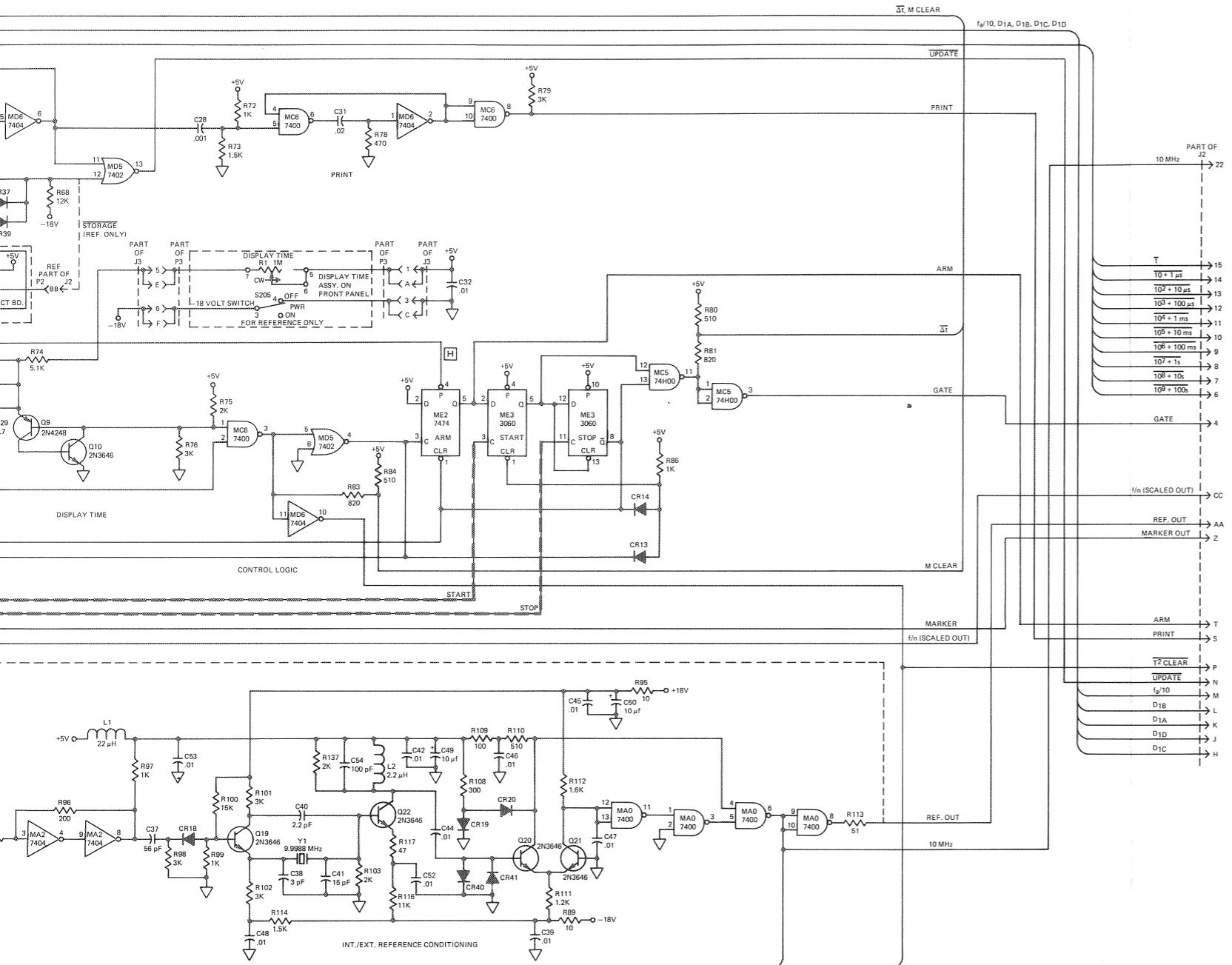


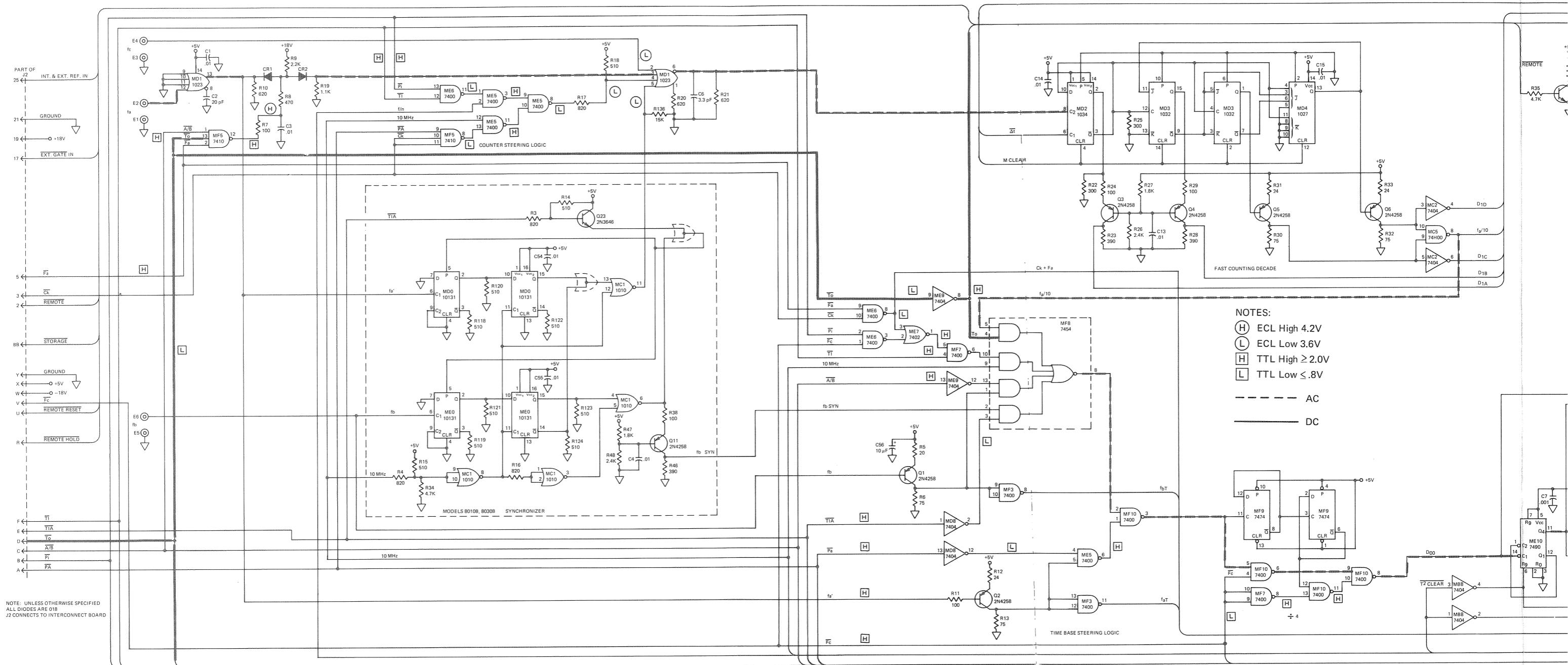


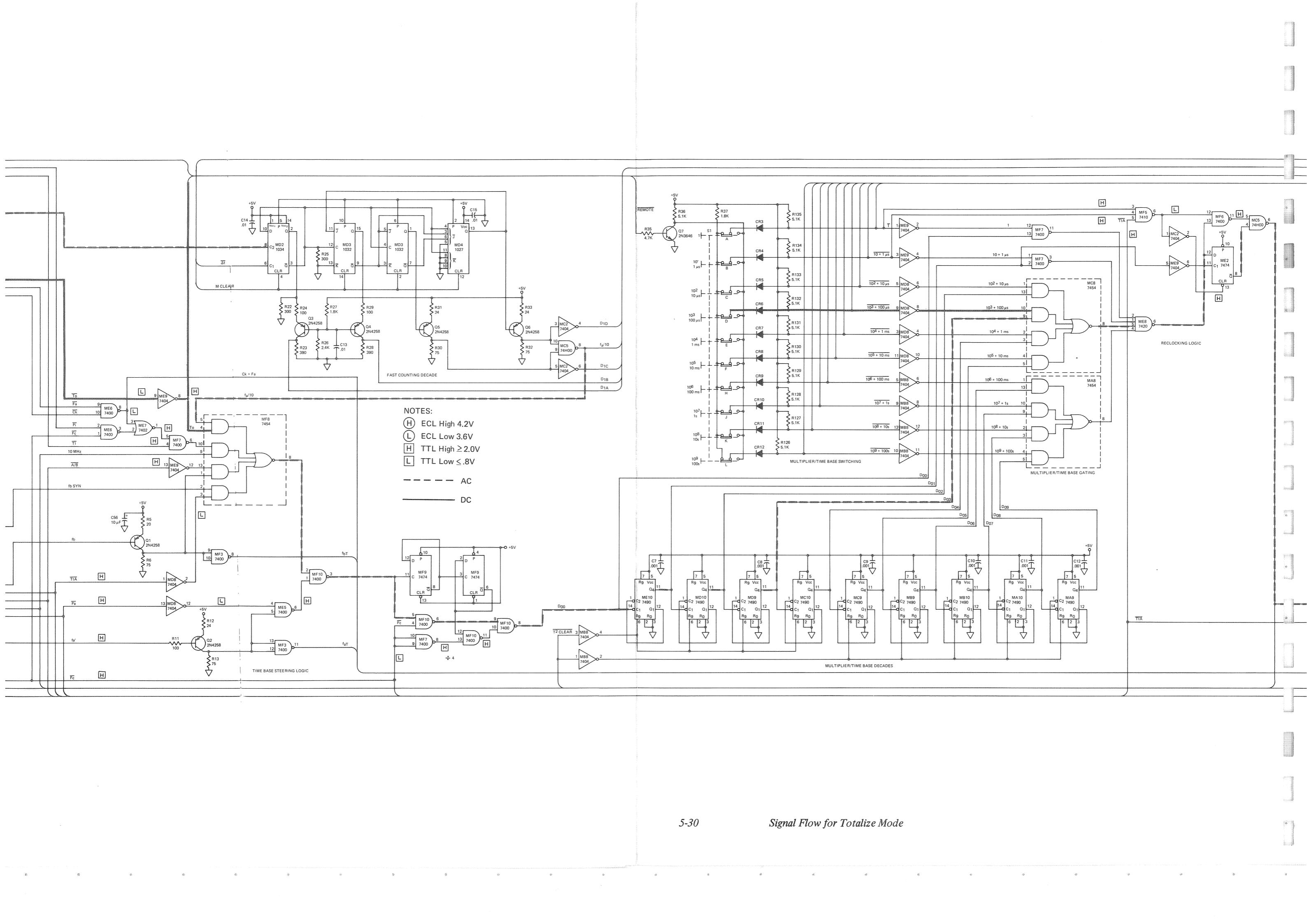


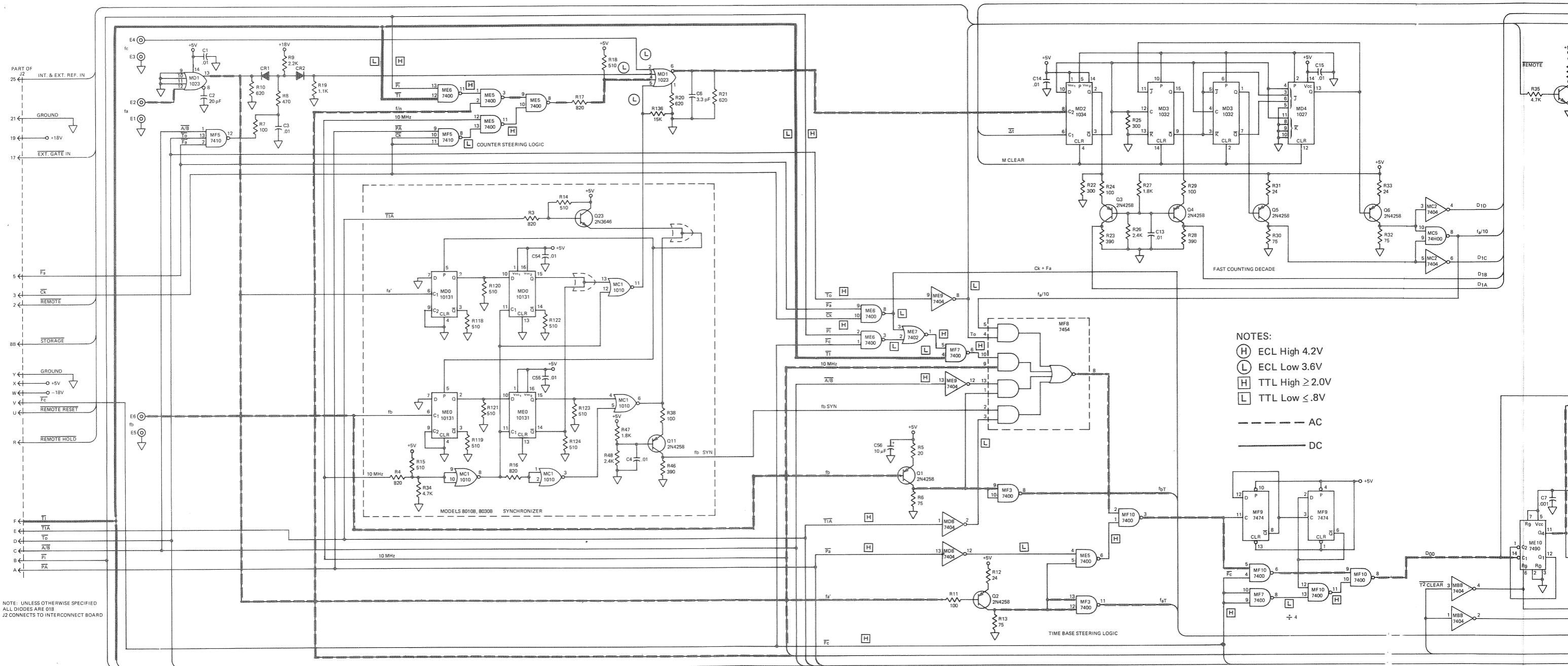


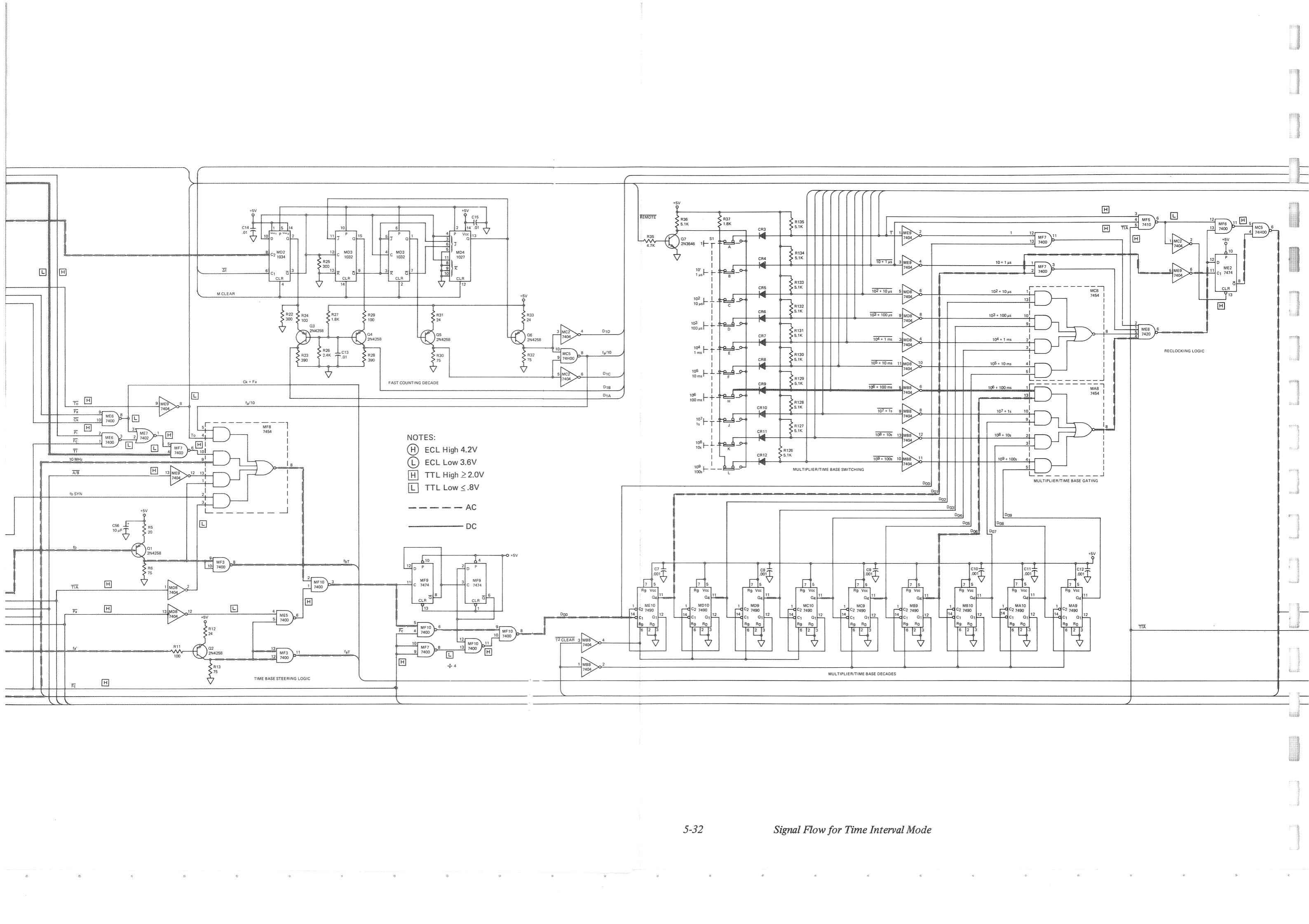


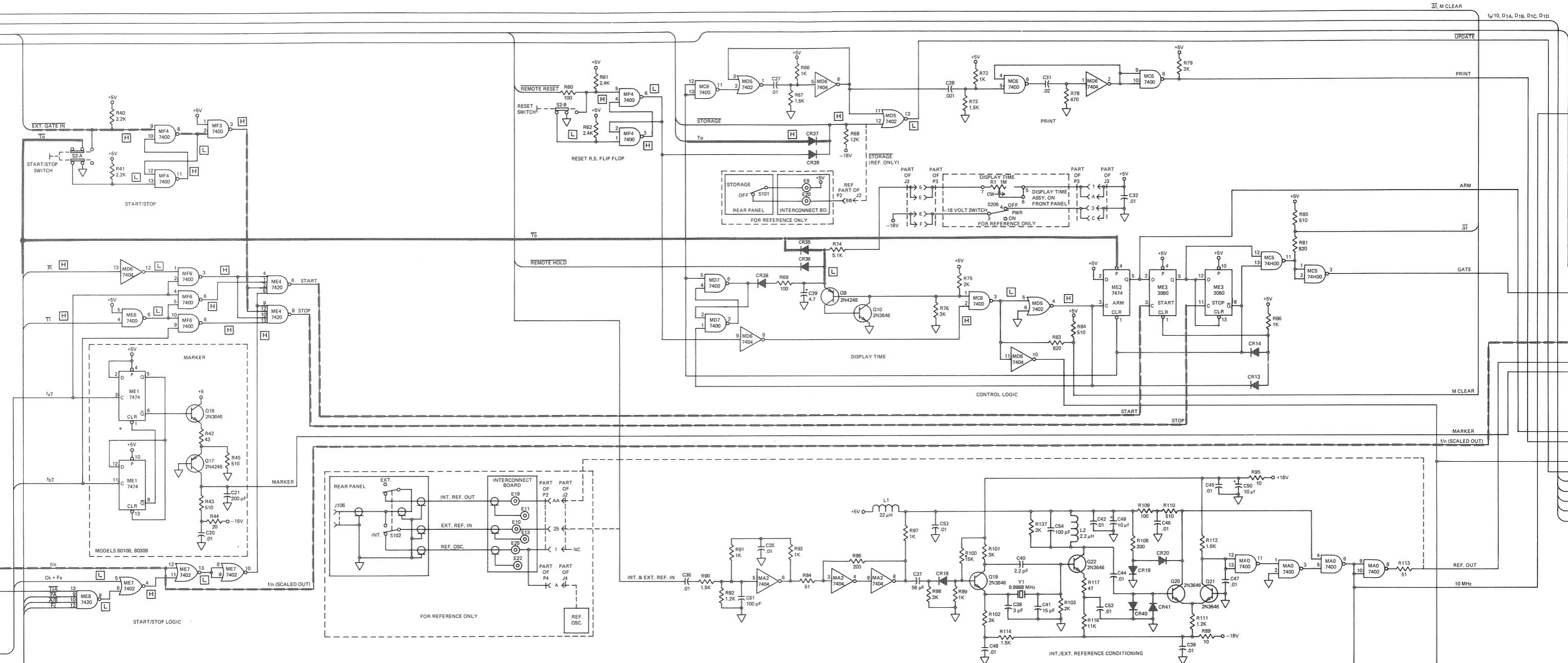


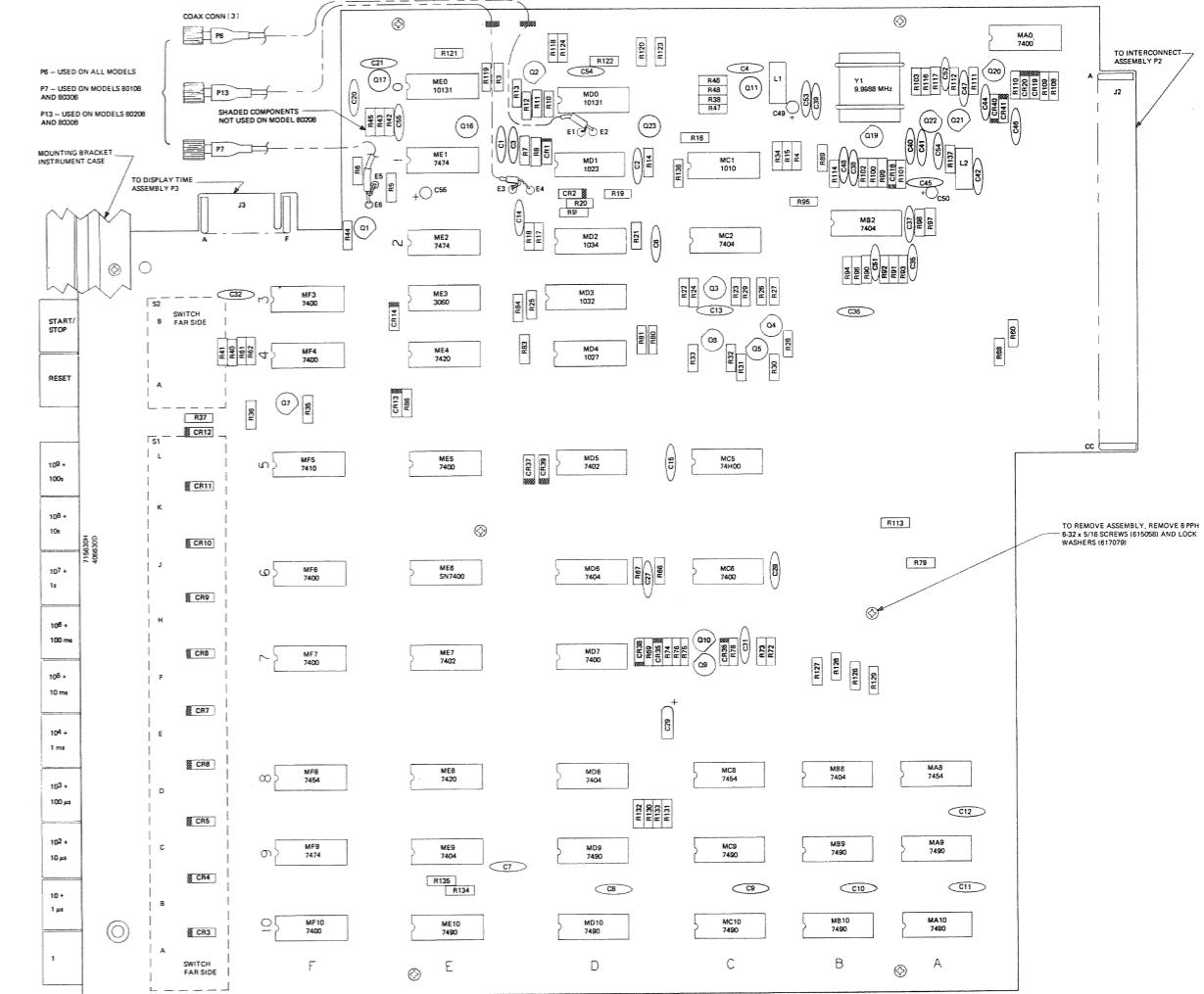
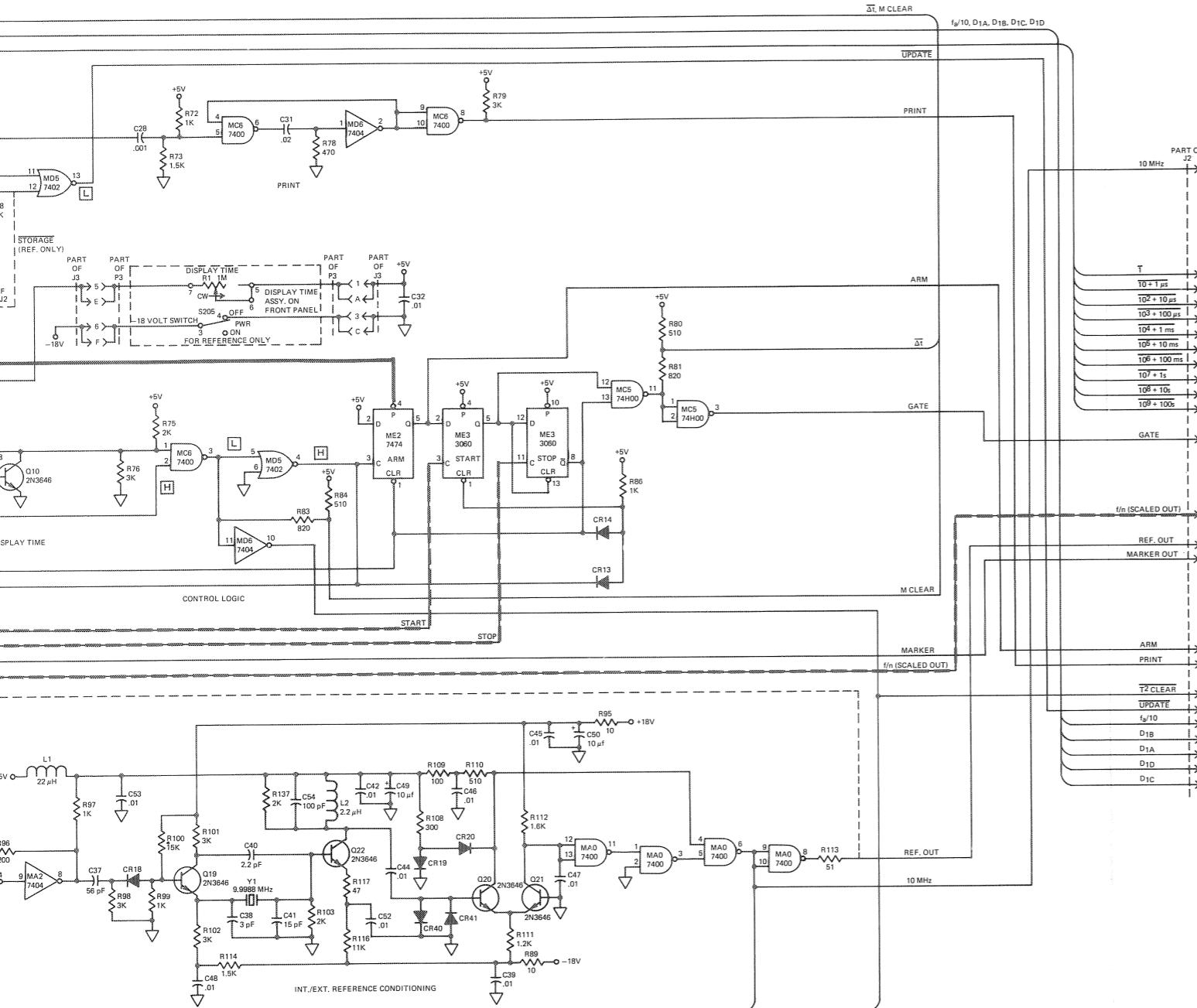


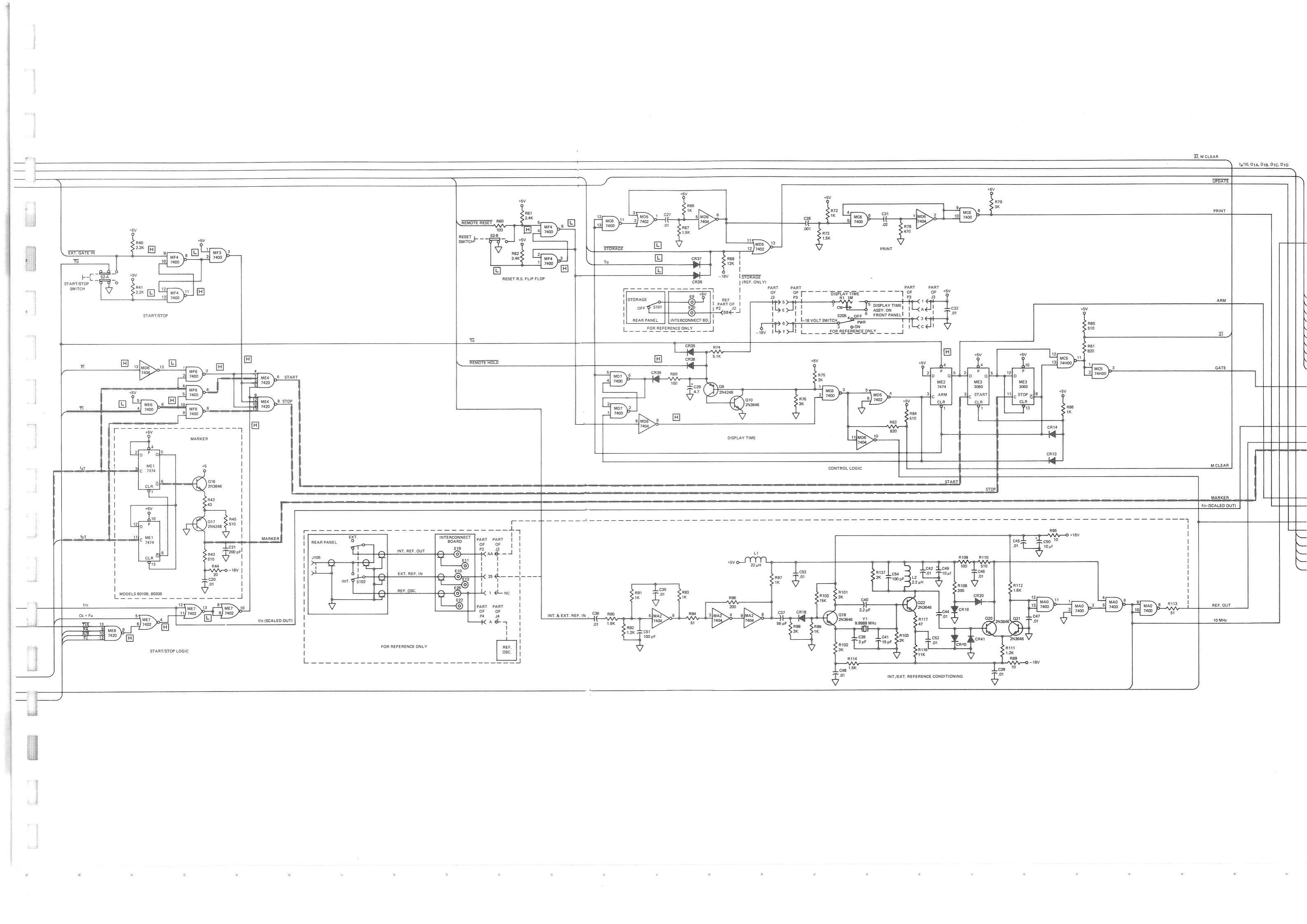


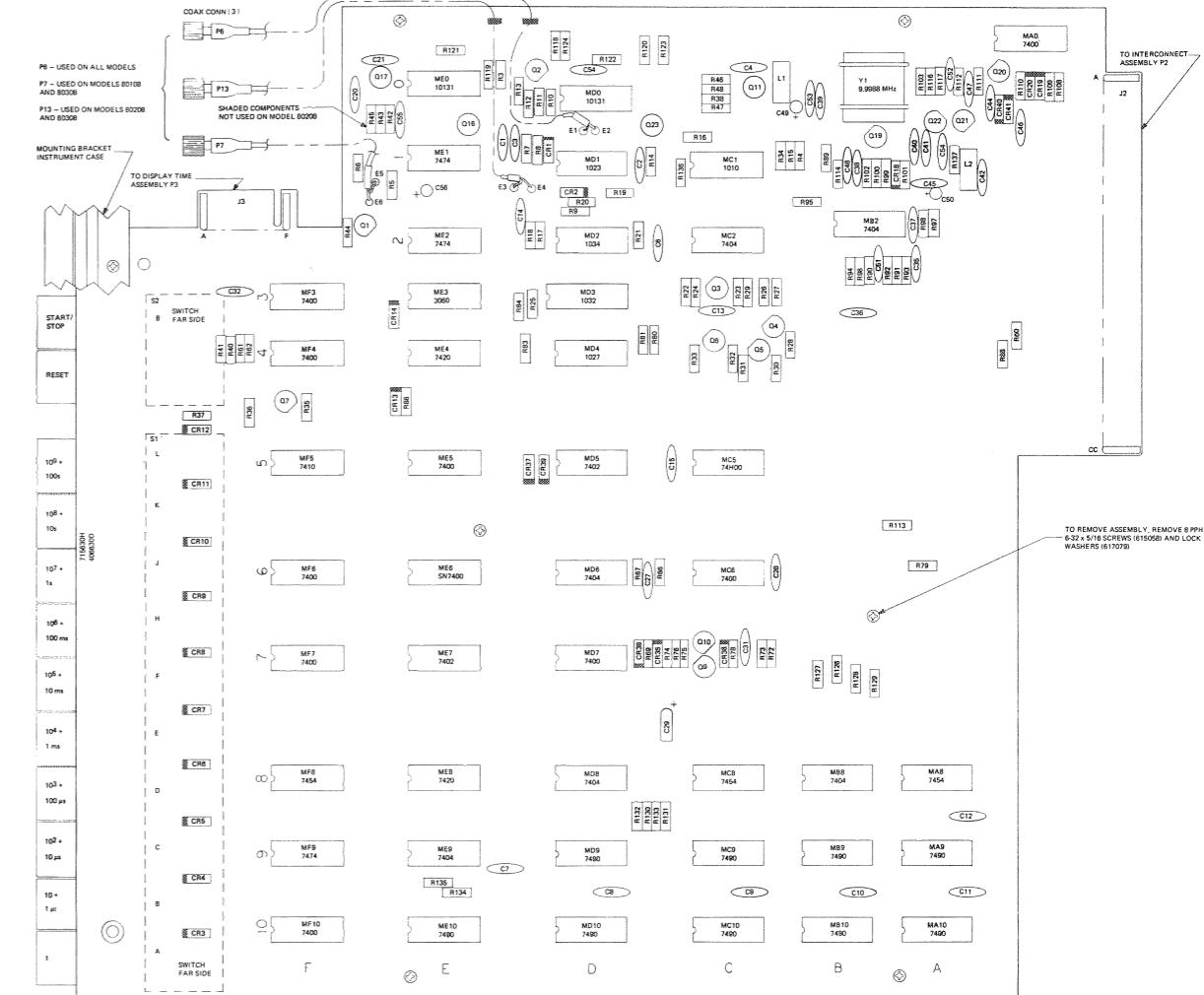
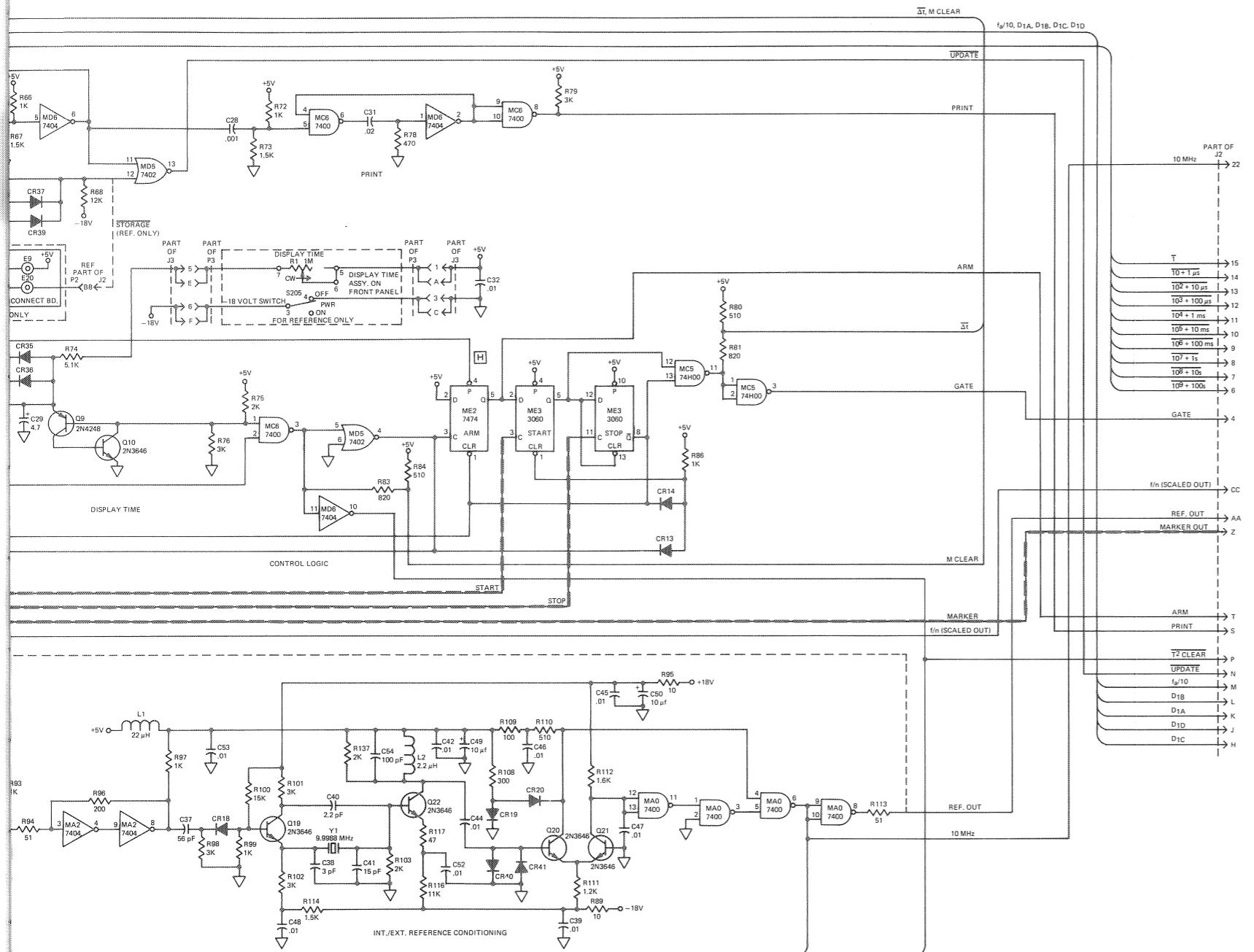


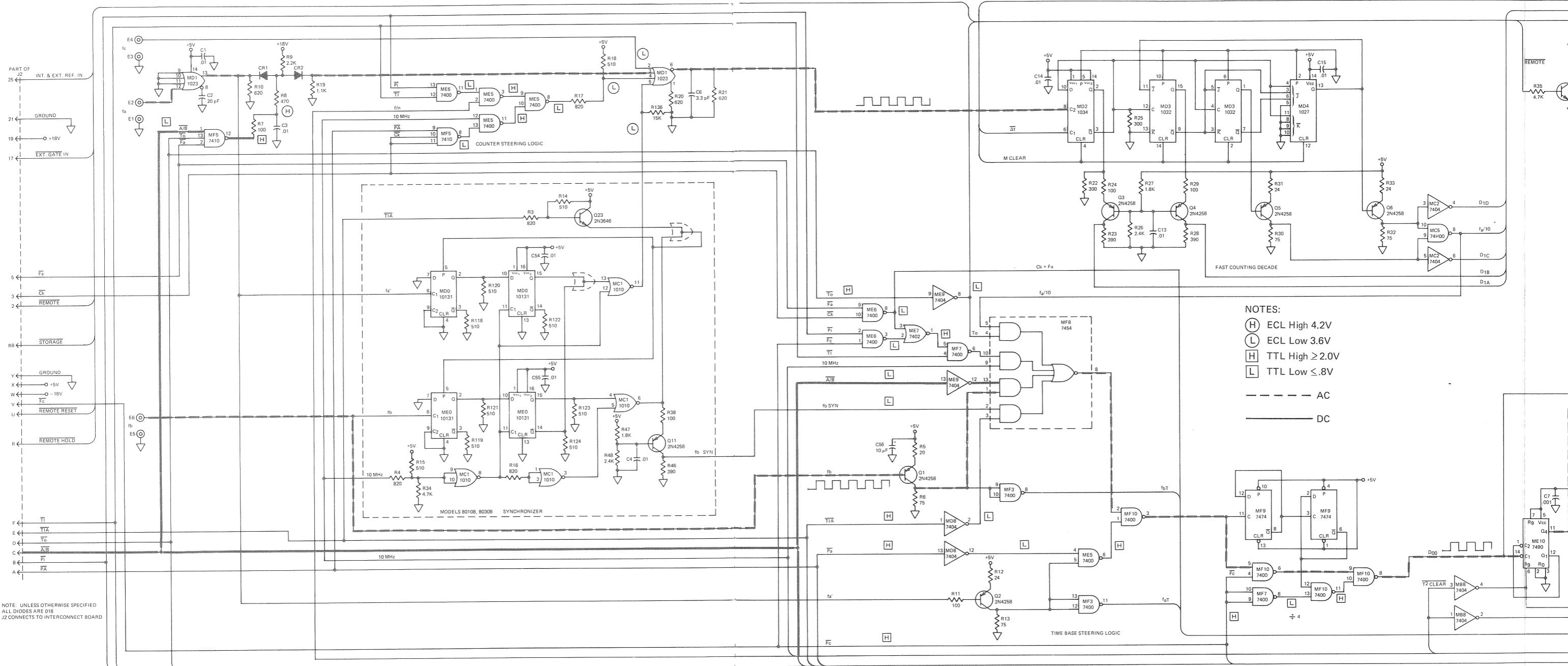


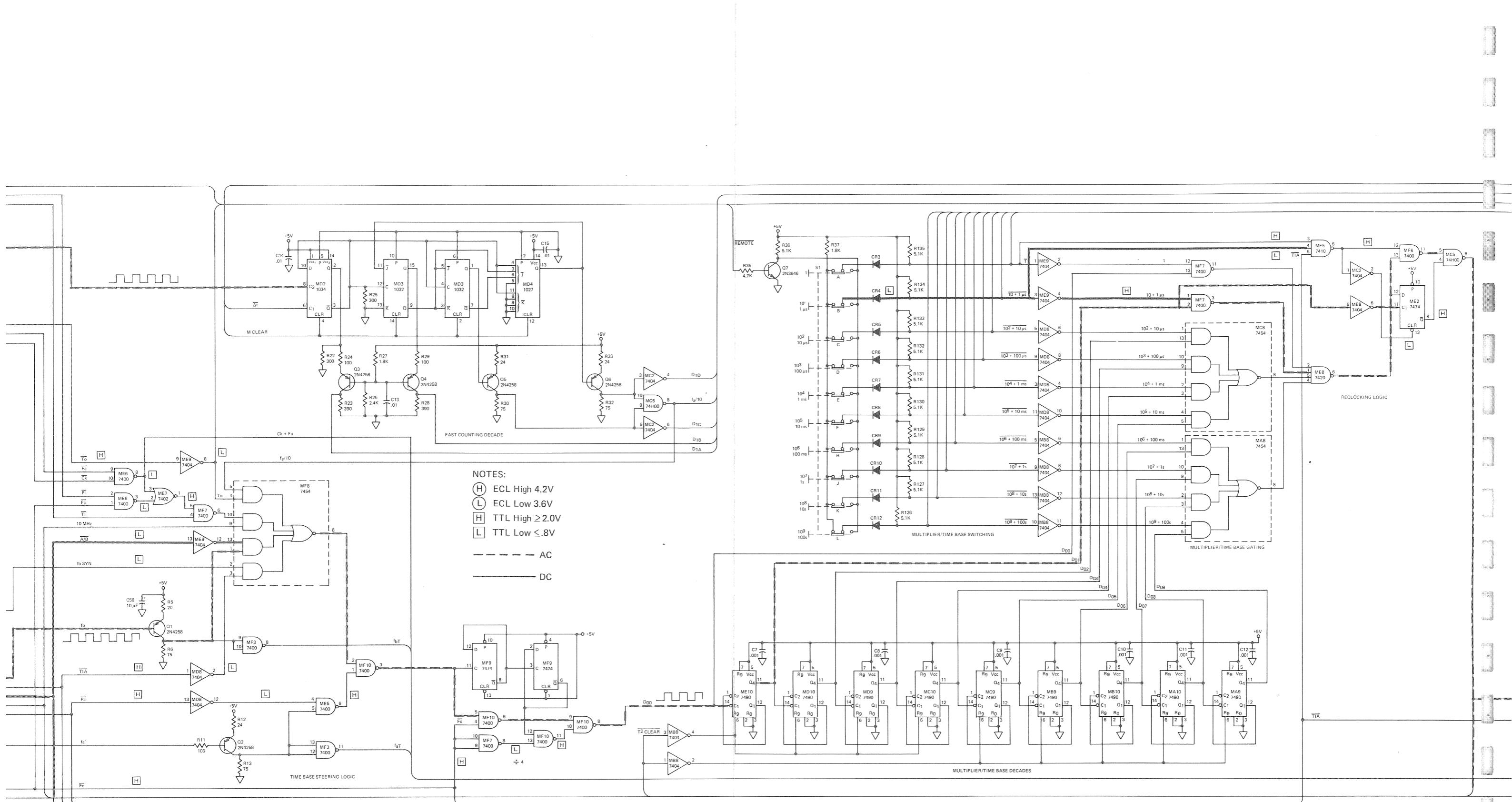


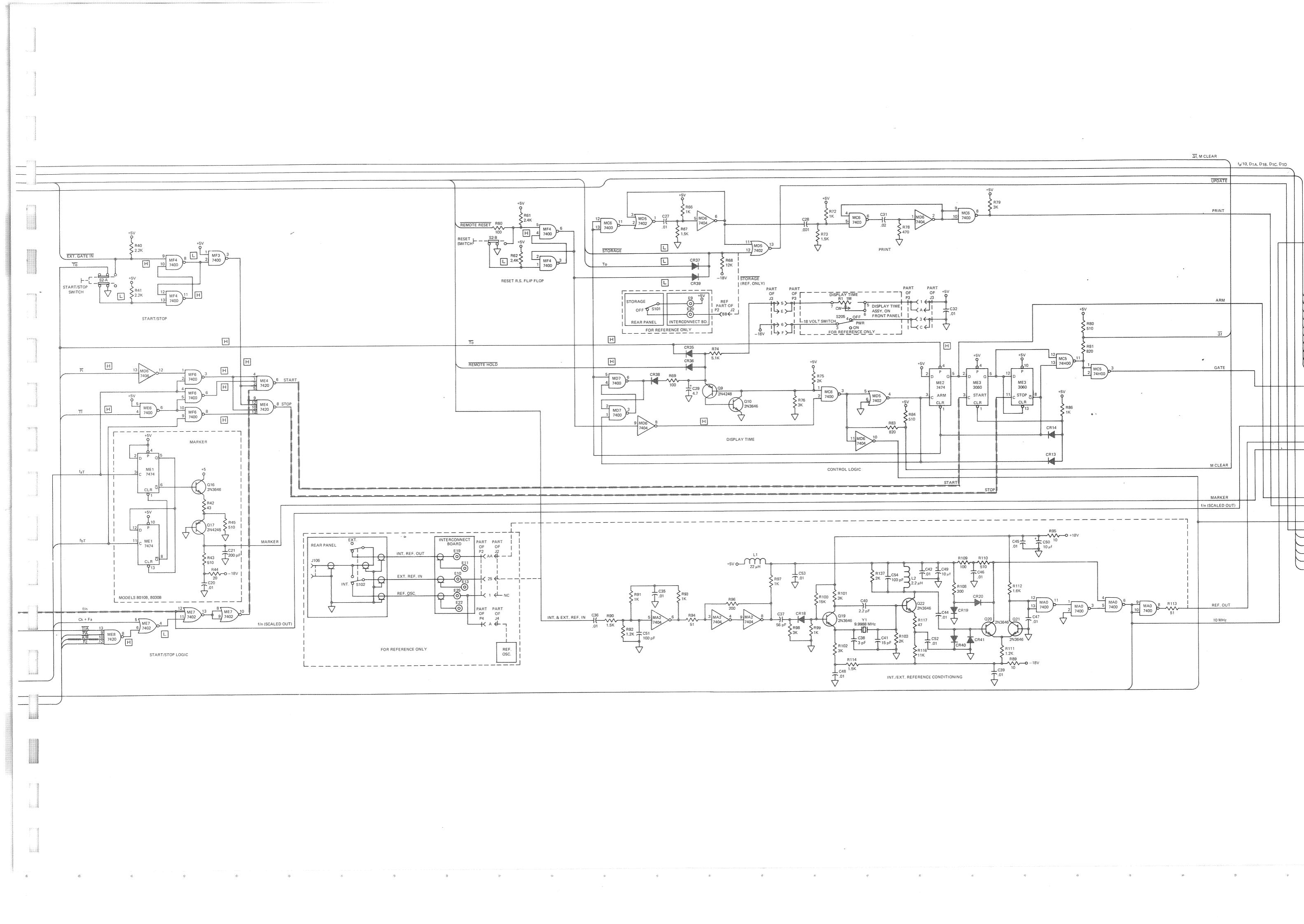


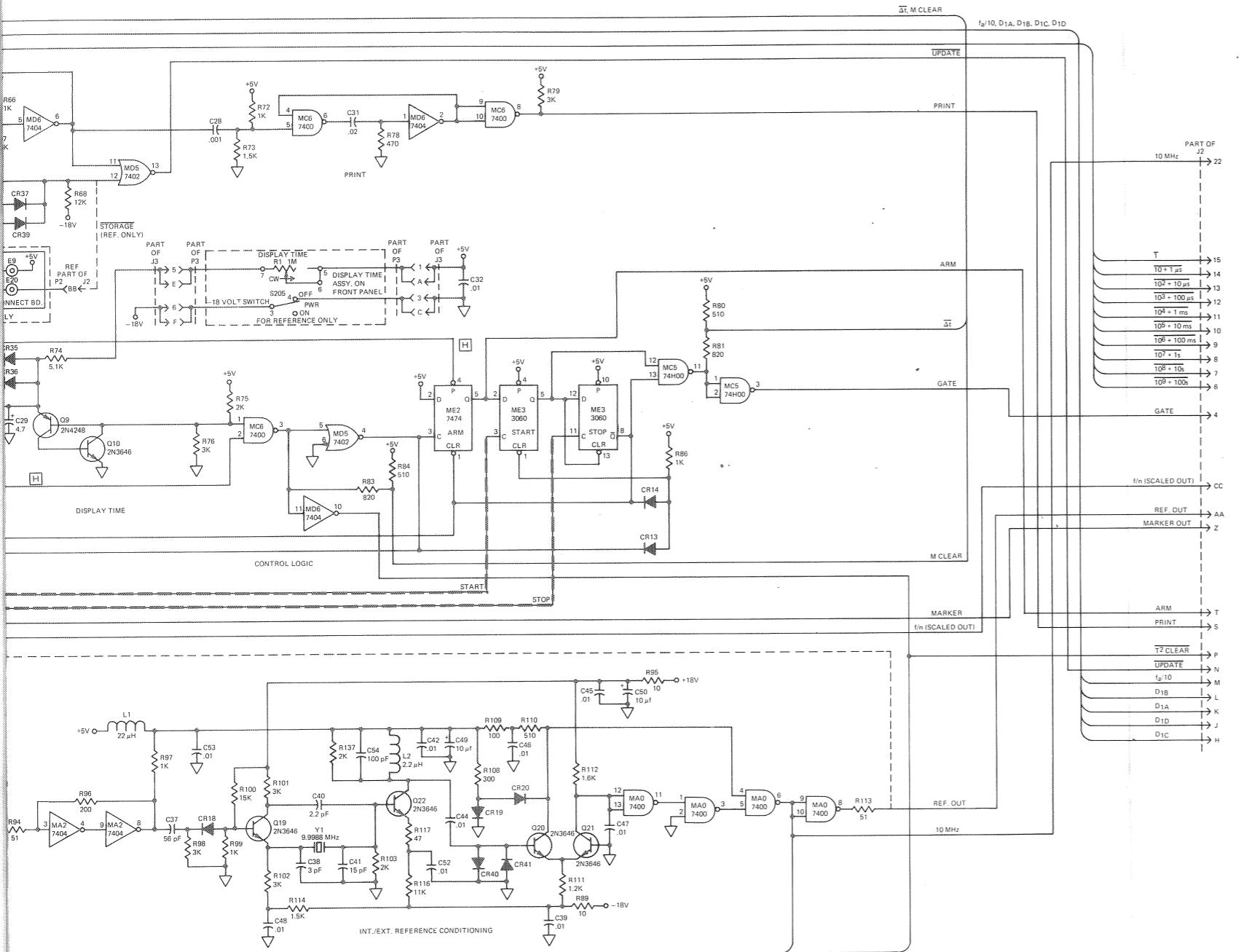


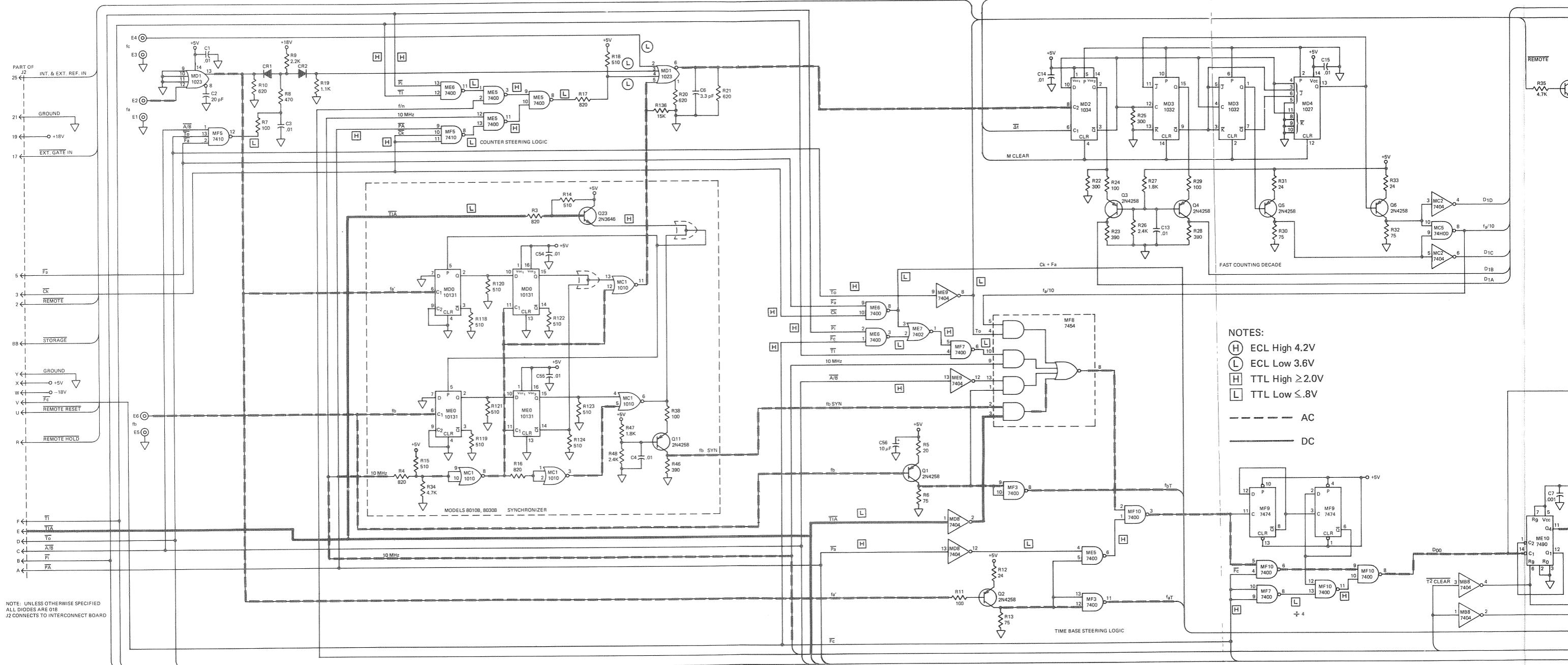


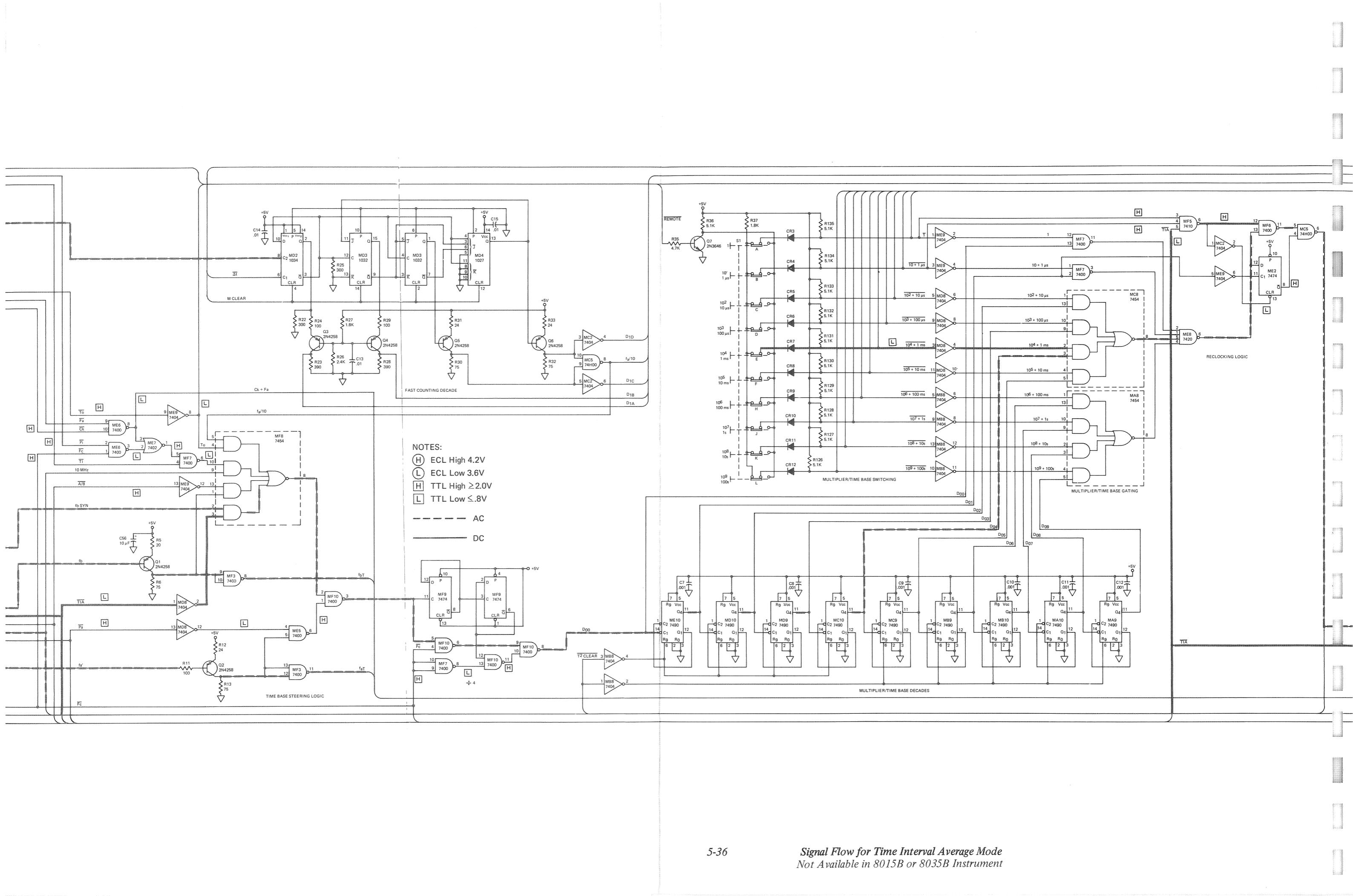


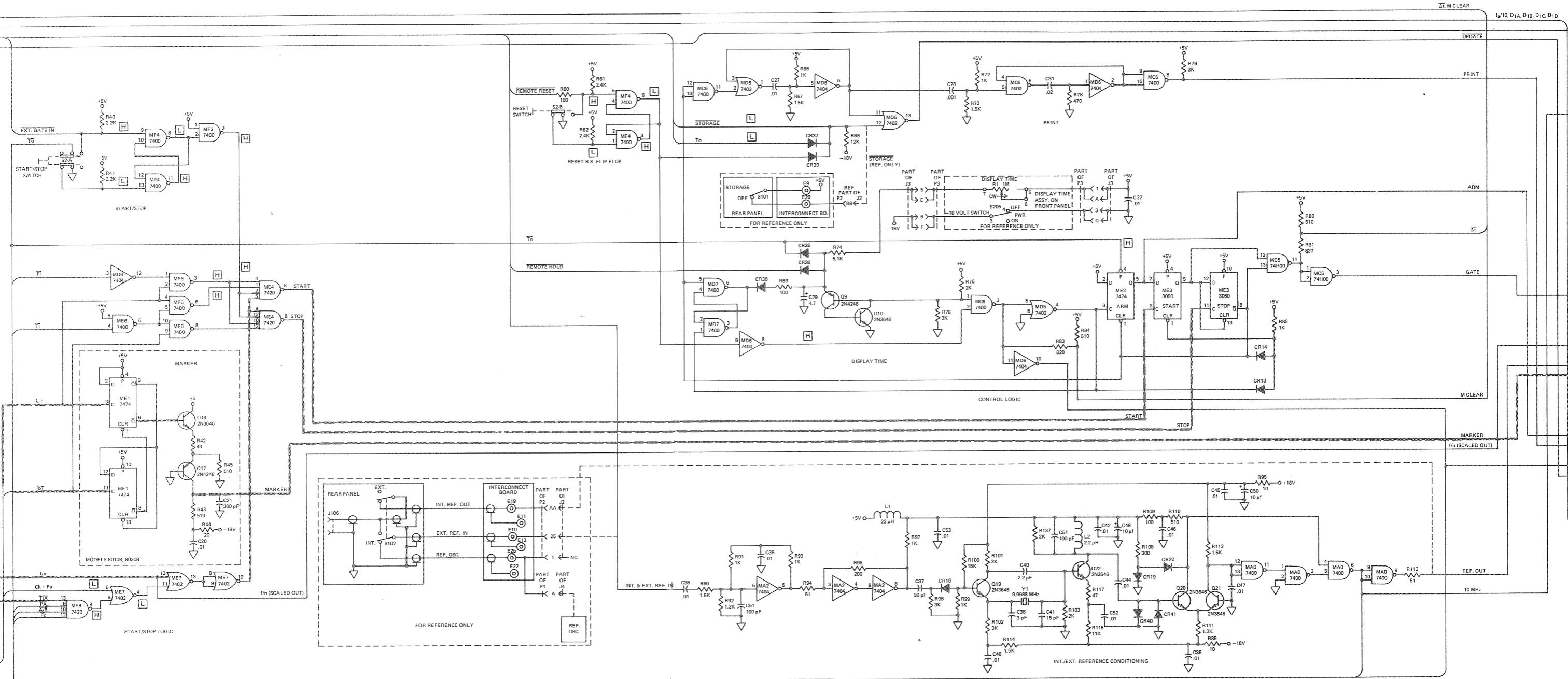


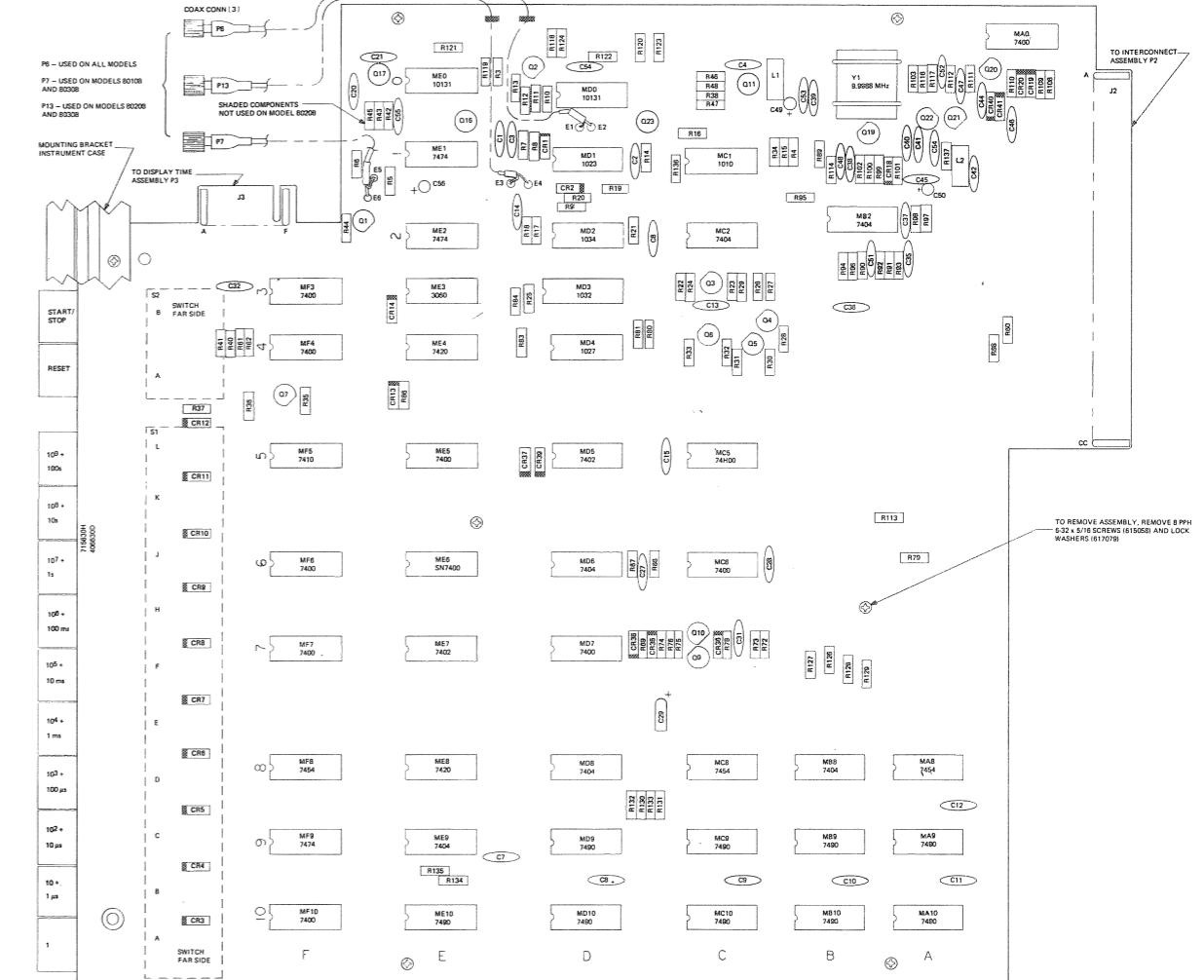
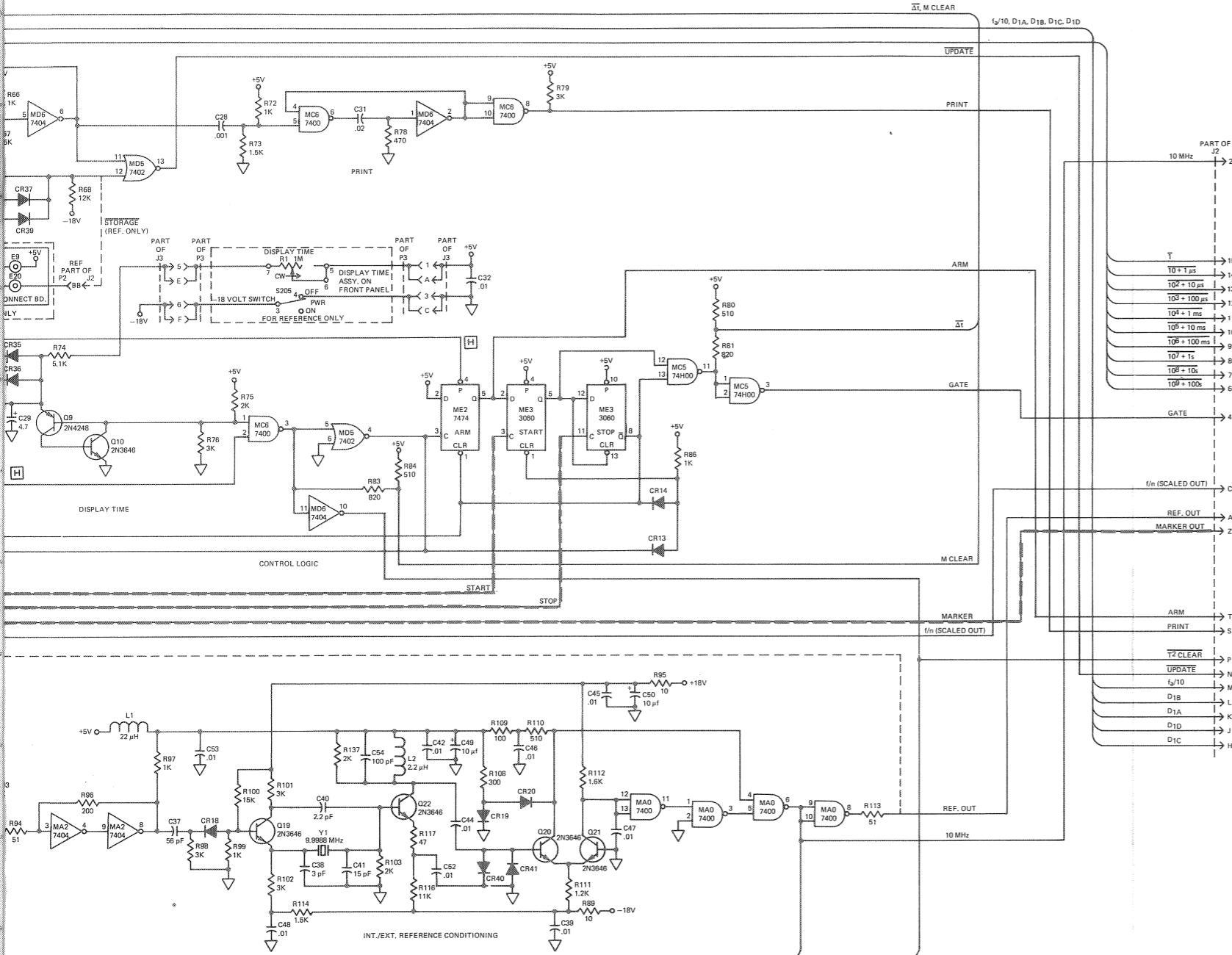












*Signal Flow for Time Interval Average Mode* 5-37  
Not Available in 8015B or 8035B Instrument